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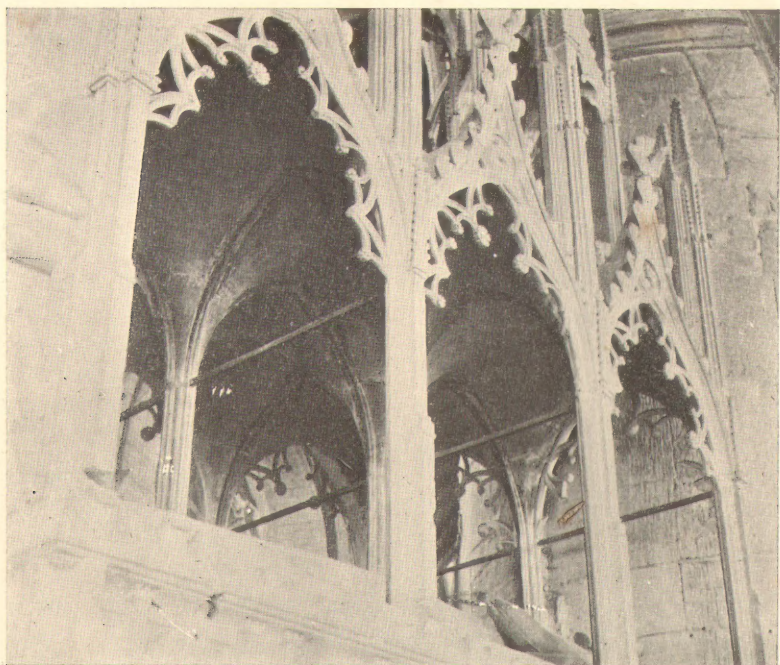
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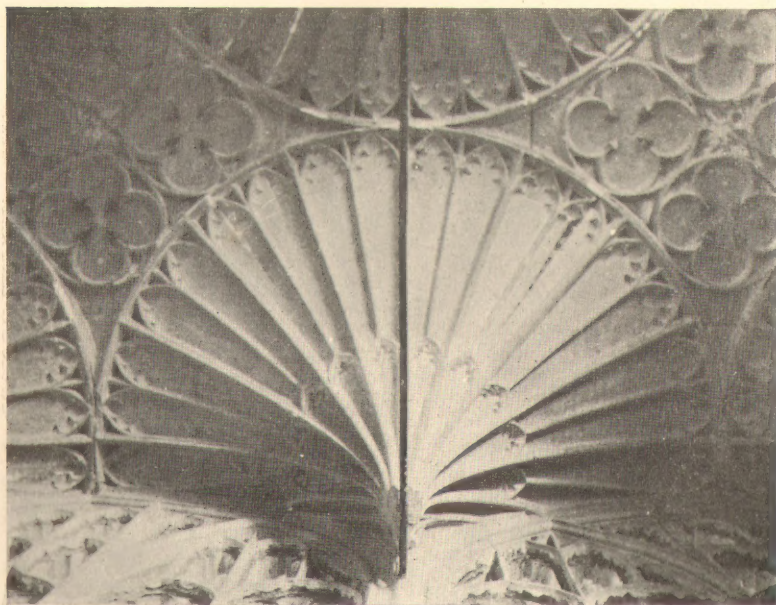
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NO. 1. TEWKESBURY ABBEY CHURCH. DESPENCER MONUMENT.



NO. 2. TEWKESBURY ABBEY CHURCH. DESPENCER CHAPEL.

FAN-VAULTS.¹

By F. E. HOWARD.

I. INTRODUCTION.

Several interesting forms of vaulting were evolved by the West of England masons of the fourteenth century. The most striking of these was the fan-vault which could be applied with equal success to small decorative canopies over tombs, to aisles or cloisters of moderate span, or to the high vaults of the greater churches. It is no exaggeration to say that the fan-vault is the most important innovation in the art of vaulting since the invention of the ribbed cross-vault. In its perfect development it combines the constructional virtues of the dome and the cross-vault. Like the dome it can be made so light as to exercise very little thrust, and even more than in the case of the cross-vault this thrust can be concentrated entirely upon the points of support.

There is very little literature on the subject. The most important account of the construction of the fan-vault is comprised in Professor Willis's paper *On the Construction of the Vaults of the Middle Ages*.² Short notices may be found in Sir G. Scott's *Lectures on Architecture* and G. G. Scott's *Essay on English Church Architecture*. That in Mr. Francis Bond's *Gothic Architecture in England*, is especially valuable for its expansion of the ingenious theory of the origin of the fan-vault first suggested by Mr. E. S. Prior in *Gothic Art in England*.

A more complete account of the fan-vault is attempted in the following pages, more fully illustrated than was possible in Willis's day, and a good many examples are included which were unknown to him.

¹ Read before the Institute, 25th July, 1910.² *Trans. R.I.B.A.* 1842.

DEFINITION.

A definition is necessary, for the term "fan-vault" has been very loosely applied to any vault whose ribs form tracery patterns, even to the lierne-vault of St. Frideswide's priory church at Oxford or to the wooden lierne-vaults of the Devonshire screens.¹

It is proposed that only vaults whose ribs are all of the same curve and spaced at equal angles with one another should be considered as true fan-vaults. If the vaults of Sherborne, Cullompton and Ottery St. Mary are to be included the definition must read "A fan-vault is a vault with many ribs,² spaced at equal angles with one another, the alternate ribs being equal in curvature." In very small vaults the ribs are sometimes frankly decorative, but this need not affect the definition, for there are no examples in this country of a fan-vault without ribs of any kind.

II. THE ORIGIN AND DEVELOPMENT OF THE FAN-VAULT.

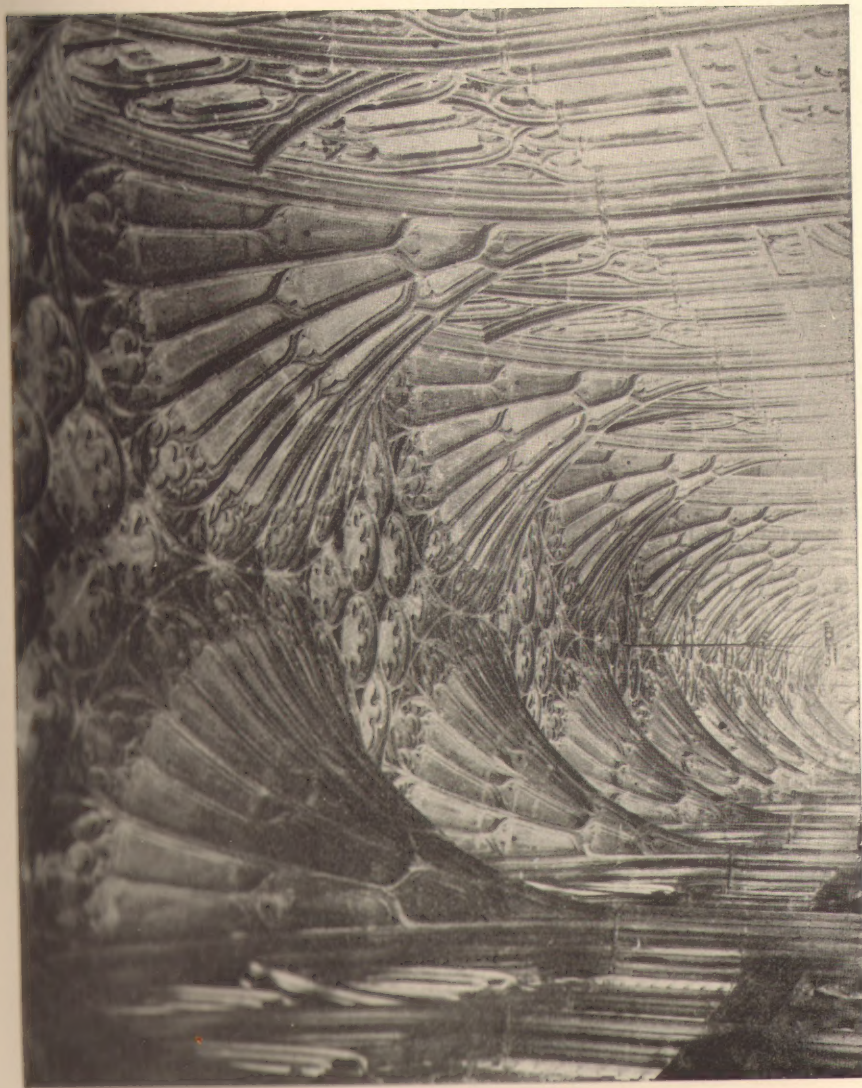
The existing examples of fan-vaulting range from the small vault of the lower part of the chantry chapel in Oxford cathedral church to the high vault of King's College chapel at Cambridge. The former is but four and a half feet in span and each bay is in only four pieces of stone, though it might be easily built in the same proportions over a span of twenty feet, while the latter is forty-five feet in span and is constructed like a lierne-vault with separate ribs and panels. There are also instances of the decorative use of the fan-vault conoid, which also deserve notice. Consequently it is no easy matter to give a consecutive account of the evolution of the fan-vault.

The fan-vault seems to have made its appearance on a very small scale and in a rather ignoble form in the monument in Tewkesbury abbey church erected to the memory of Sir Hugh Despencer and his wife (plate I, no. 1).

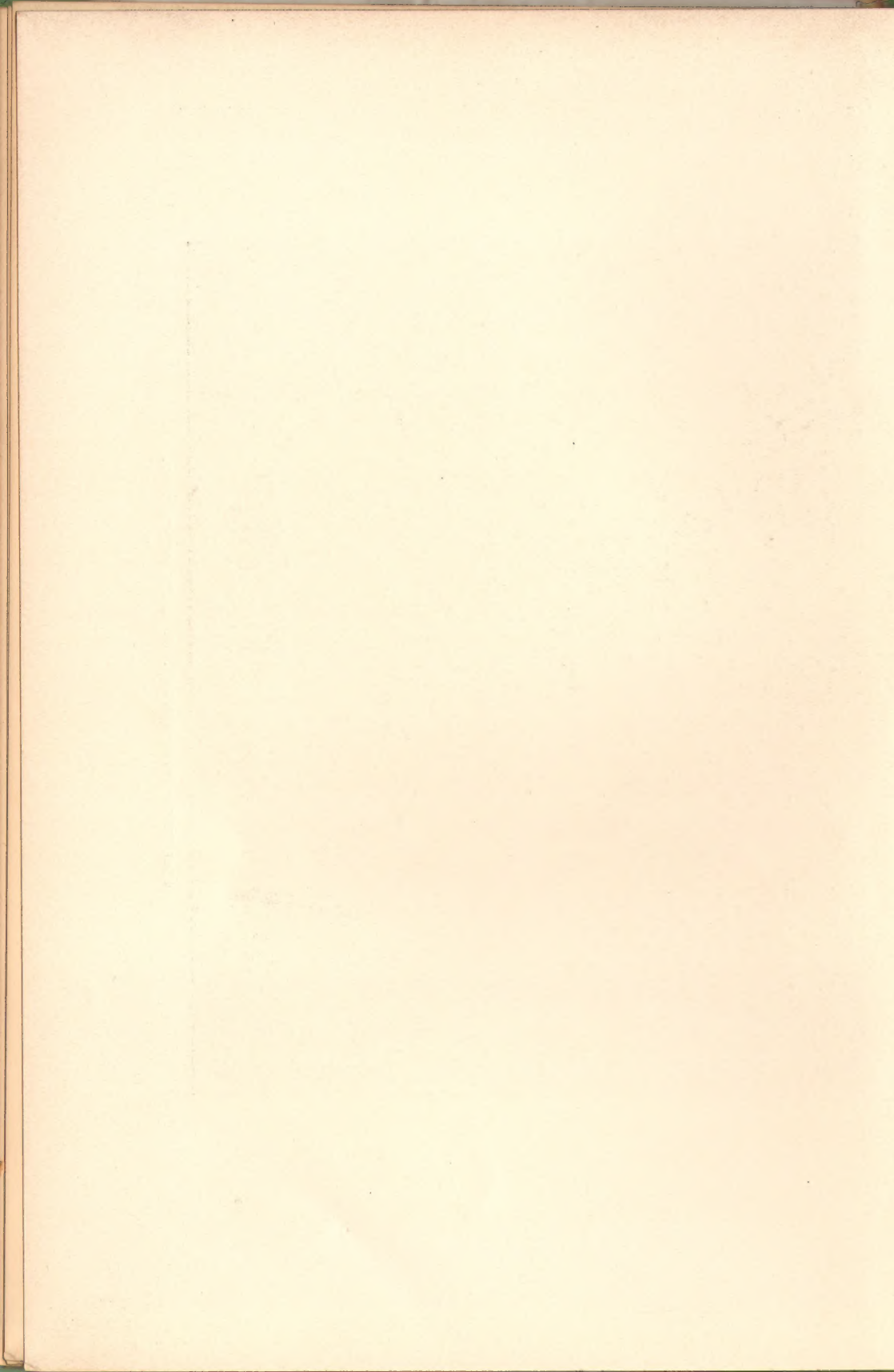
¹ True fan-vaults in wood occur in the screens of Dilwyn and Bosbury, Herefordshire. The vaulting of the screen at Fitzhead, Somerset, may also be considered

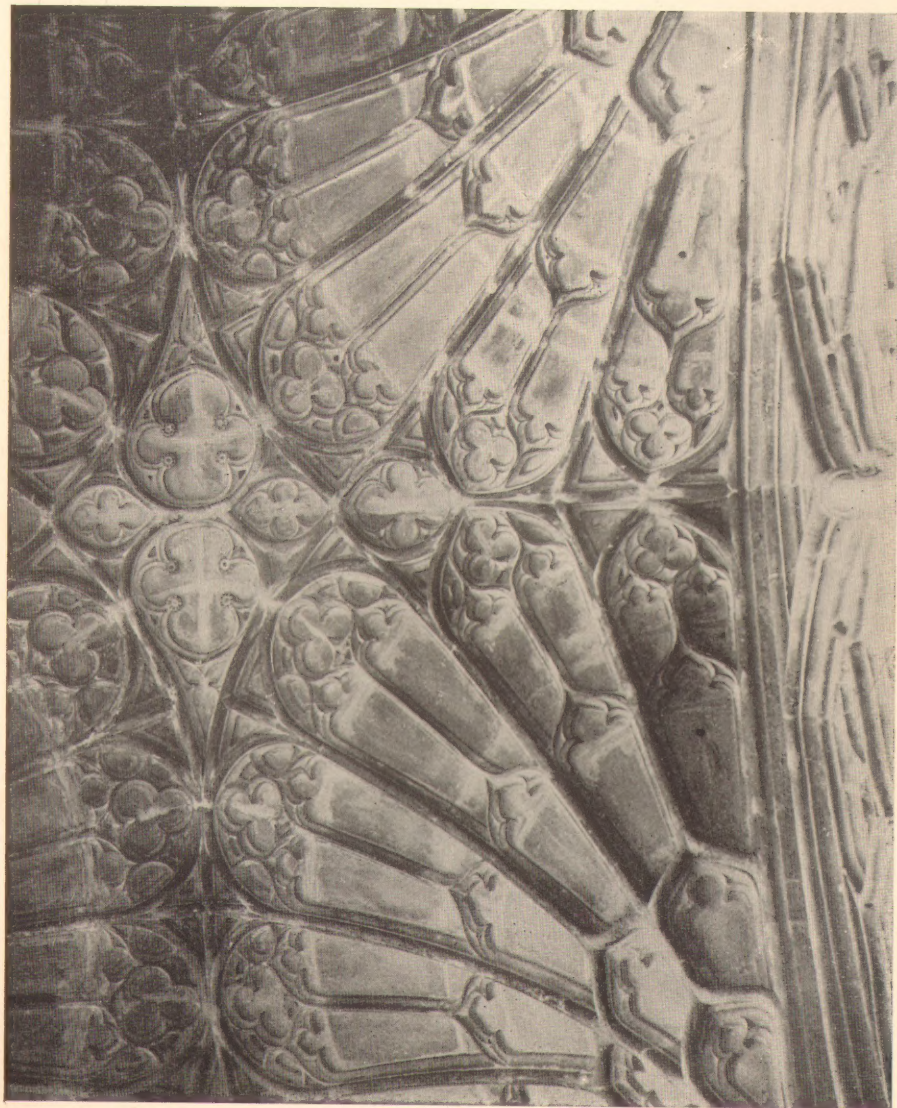
as a fan-vault, though the fans (which are bounded by ribs circular on plan) are tilted.

² To exclude a ribbed quadripartite vault over a square plan.



GLoucester ABBey CHURCH. E. ALLEY OF CLOISTER.





GLOUCESTER ABBEY CHURCH. E. ALLEY OF CLOISTER. OBLONG BAY.

Sir Hugh died in 1349 and the tomb must have been erected soon after his death, for it strongly resembles the tomb of Edward II at Gloucester (built soon after 1325), though it has the cold wiry look which is so characteristic of the work done just after the Black Death. The tomb has an elaborate tabernacled canopy, vaulted beneath with what is in form, though not in construction, a fan-vault in six square bays (fig. 1). Such canopies were not uncommon at this period, but they usually took the

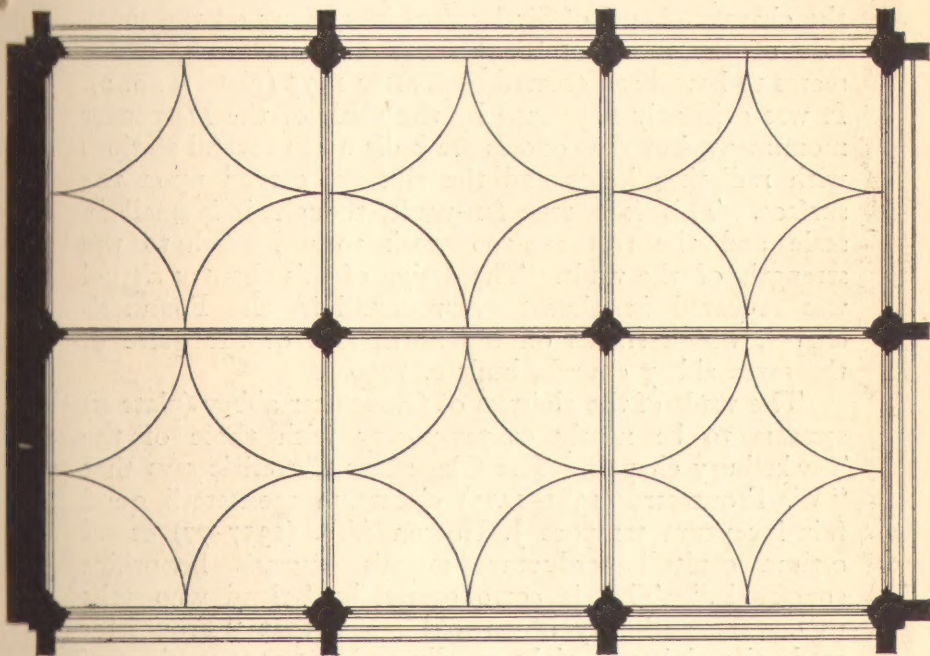


FIG. 1. PLAN OF DESPENCER MONUMENT, TEWKESBURY ABBEY CHURCH.

form of a ribbed cross-vault, often with intermediate ribs, carved out of solid stone. These were difficult and expensive to work, for the ribs were of various curves and the panels were complicated winding surfaces. The vault of the Despencer monument has obviously had little time or money spent upon it. Carved ribs are omitted and the mason has only used one curved template to guide him, and consequently the vault takes the form of several inverted conoids or parts of conoids, butting up against

a flat ceiling. It would have been possible to turn this vault in the lathe instead of carving it, though this does not appear to have been done. When the vault was worked to shape it was coloured terra cotta, and ribs, probably of a greenish stone colour, were painted upon it. The result must have been quite pretty, though unworthy of the canopy work above it; here we have the idea which afterwards produced the magnificent vaults of King's College chapel and Bath abbey church.

Some years later a vault of similar form was built in the chantry chapel of Sir Edward Despencer on the south side of the quire of Tewkesbury abbey church, which seems to have been erected soon after 1375 (plate 1, no. 2). It was evidently suggested by the vault of the Despencer monument, but the conoids are built up in several sections with radiating joints and the ribs are carved upon the surface. This is a true fan-vault, though it is small in scale and the ribs are too weak to add much to the strength of the vault. The design of this chantry chapel was repeated in almost every detail in the Founder's chapel, which stands on the north side of the quire of the same abbey church, built c. 1390.

The vault of the cloisters of Gloucester abbey (plate 11) appears to be nearly contemporary with those of the Tewkesbury chapels. The Gloucester Chronicle says that "W. Froucestre (1381-1412) claustrum monasterii quod fuit inceptum tempore J. Horton Abb. (1357-77) et ad ostium capituli perductum magnis expensis honorifice construxit." This is corroborated by Leland who tells us on the authority of an old monk that "Froucester made the cloister a right goodly and sumptuous piece of work." Thus the fan-vault appears to have been designed before 1377 and completed about 1412. The cloister was clearly intended from the first to be fan-vaulted as the section of the vaulting shafts clearly proves¹, for the same ingenious section occurs in the vaulting shafts of the fan-vaults of Sherborne, Wells cloister lady chapel, Tewkesbury cloisters and Hereford, but there seem

¹ G. G. Scott asserts that these shafts are planned for a lierne-vault, which is most improbable: (a) because the ribs of the present fan-vault fit upon the vaulting shafts exactly, and these ribs are too small

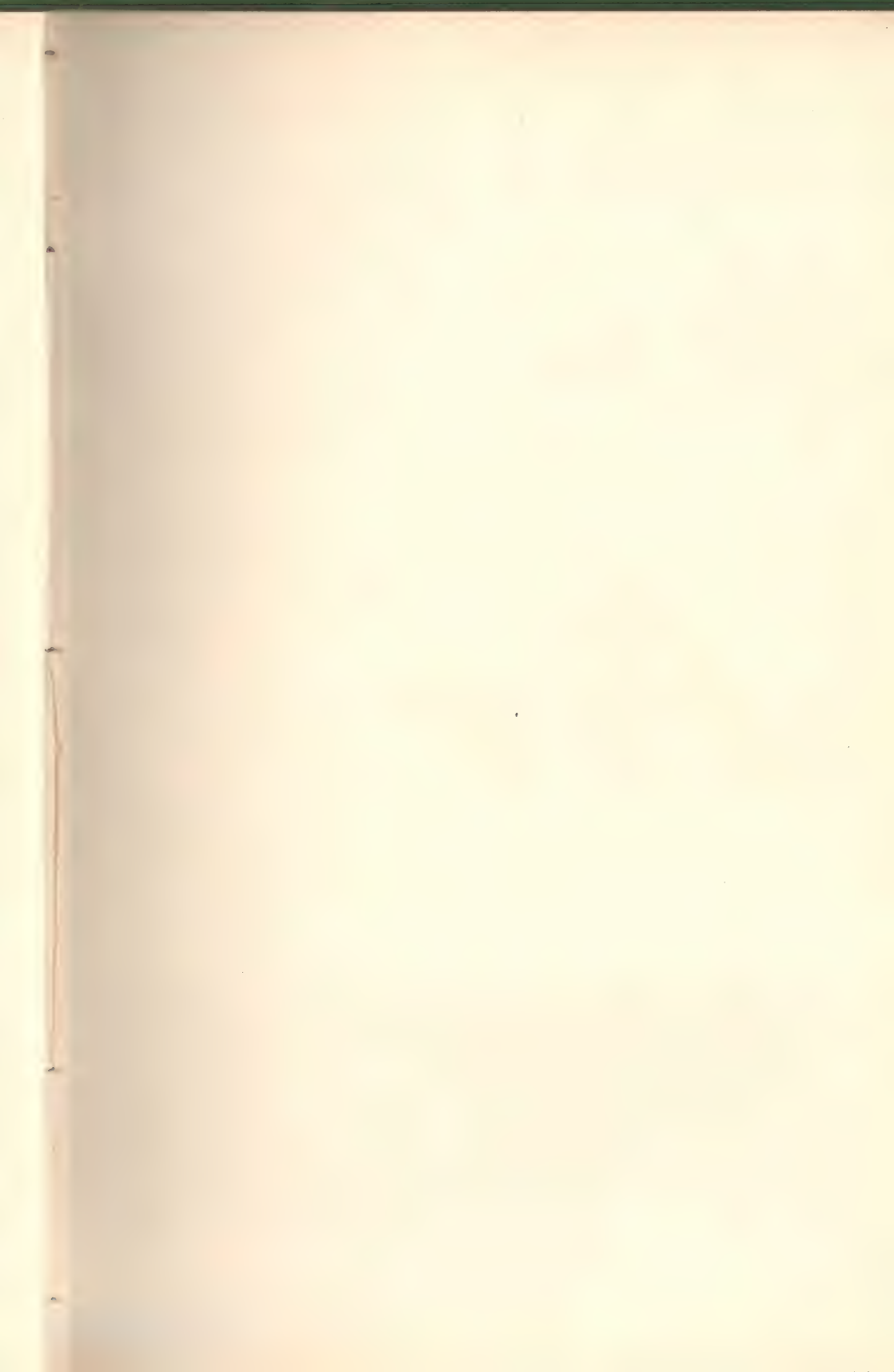
for a lierne-vault; (b) because the fan-vault is in perfect harmony with the panelling of walls and windows, whereas the panelling especially is far too shallow to harmonise with a lierne-vault.



NO. 2. BURFORD CHURCH, OXON. S. PORCH.



NO. 1. GLOUCESTER ABBEY CHURCH, LAVATORY.





NO. 1. TEWKESBURY ABBEY CHURCH. LIERNE-VAULT OF QUIRE.



NO. 2. TEWKESBURY ABBEY CHURCH. LIERNE-VAULT OF TRANSEPT.

to be no examples of its use in conjunction with a lierne-vault. The architectural evidence confirms that of the Gloucester Chronicle and Leland. The tracery of the vault of the first part of the work, that is from the eastern nave doorway to the chapter-house, is different in design. Trefoils occur in the upper part of the tracery of the conoids, whereas in the north, south, and west walks quatrefoils are substituted. The rest of the east walk retains the trefoiled tracery, but while the panels on the conoids of the first section are only arched and cusped at the top; the second and third tiers of panels of the next two bays are cusped at the bottom as well. The next three bays, which complete the east walk, have all their panels cusped at top and bottom. The vault of the other walks with the quatrefoiled tracery does not vary in design; like the first work the lower ends of the panels are not cusped. It seems likely, therefore, that the rebuilding of the vault was commenced at the south-east angle and continued as far as the chapter-house doorway; then the rest of the work was taken in hand, two or three bays at a time, the work of the south walk being built last, for the carrels of the monks were placed there and the rebuilding must have caused much inconvenience.

Although most of the bays are square or nearly so, an oblong bay occurs in the first section of the vault (plate III). The difficulty of covering it with a fan-vault is surmounted by allowing the conoids to intersect. This is a very important example, for it is the first step towards the entire elimination of the flat spandrel, which as yet rendered it impossible to construct fan-vaults of more than about twenty feet span.

This vault, like those of the Tewkesbury chantry chapels, is built in solid stone, with the tracery carved upon the surface, but the span is twice as great (for the width of the cloister is twelve feet), and the panels are more deeply sunk, so that the ribs project more boldly and are of more constructional use. The design of the tracery is far more beautiful.

The lavatory was also fan-vaulted, probably in the first years of the fifteenth century (plate IV, no. 1). Though only half its span, the ribs are the same size as those of the cloister. It would be

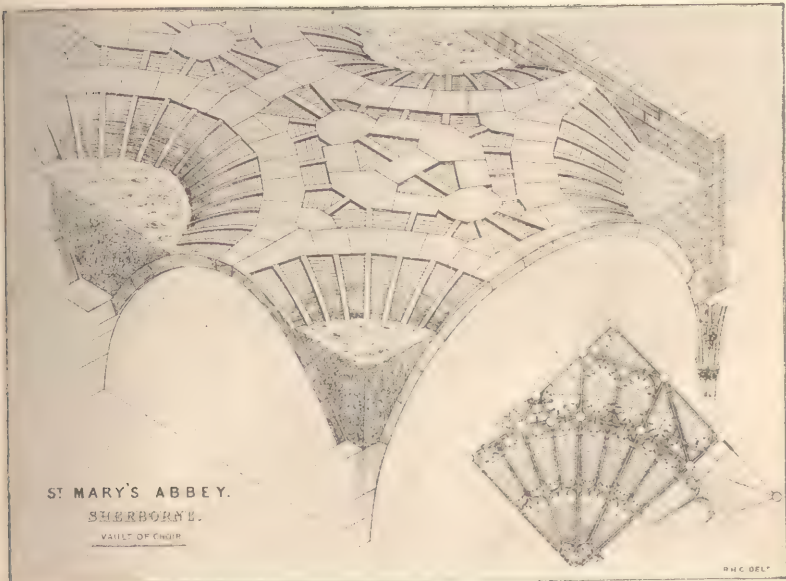
easy to build this vault with separate ribs and panels, whereas it would be difficult to build the vault of the cloisters in this manner, for the ribs are rather slender to stand alone safely. The design of the Gloucester cloisters was copied shortly after at Tewkesbury.

In the first half of the fifteenth century the fan-vault became more general. There are small examples in the chantry chapel of Henry IV in Canterbury cathedral church, built soon after 1413; in the passage to the ante-chapel of All Souls College, Oxford, c. 1447; in the chantry chapel of cardinal Beaufort in Winchester cathedral church, c. 1445, and in the porch at Burford (plate iv, no. 2). These vaults are not of great importance, but the substitution of the four-centred arch for the pointed arches of Gloucester and Tewkesbury has a few advantages. The ugly collision between the conoid and the flat central spandrel is softened off, the vault is not so convex and the tracery is less distorted; it is consequently easier to work. The use of the four-centred arch increases the thrust, but this is a small matter, for the fan-vault, being entirely of cut stone, can be made exceedingly thin and light.

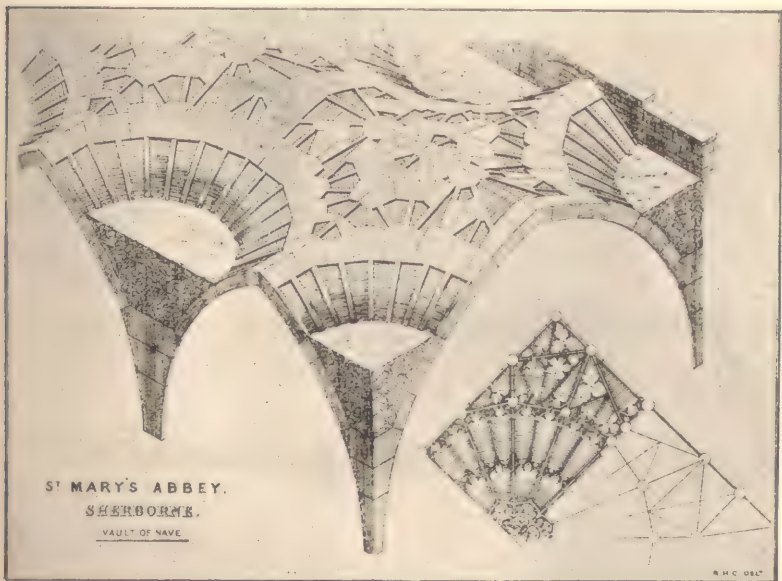
These are all of very small span. The fan-vault was not used in a large construction until nearly a hundred years after its first appearance. This is extraordinary, for English vaulting had been gradually tending towards the fan-vault form for some time before the erection of the Tewkesbury tomb and chapels. The introduction of a number of intermediate ribs is usual in vaults built after 1250; and in the high vaults at Exeter,¹ and in the chapter-houses of Lincoln, c. 1230, and Wells, c. 1310, there is certainly some attempt to space the ribs at equal angles with one another. The effect of these vaults irresistibly suggests the fan-vault, but in each case the designer of the vault has first settled the shape and position of the ridge rib and has manipulated the arched ribs to suit; and therefore the latter are of various curves and the shape of each springer is unsymmetrical.² Ribs of equal curve and symmetrical springers were impossible until ridge

¹ Lady chapel, c. 1270; quire, c. 1280; nave, c. 1308.

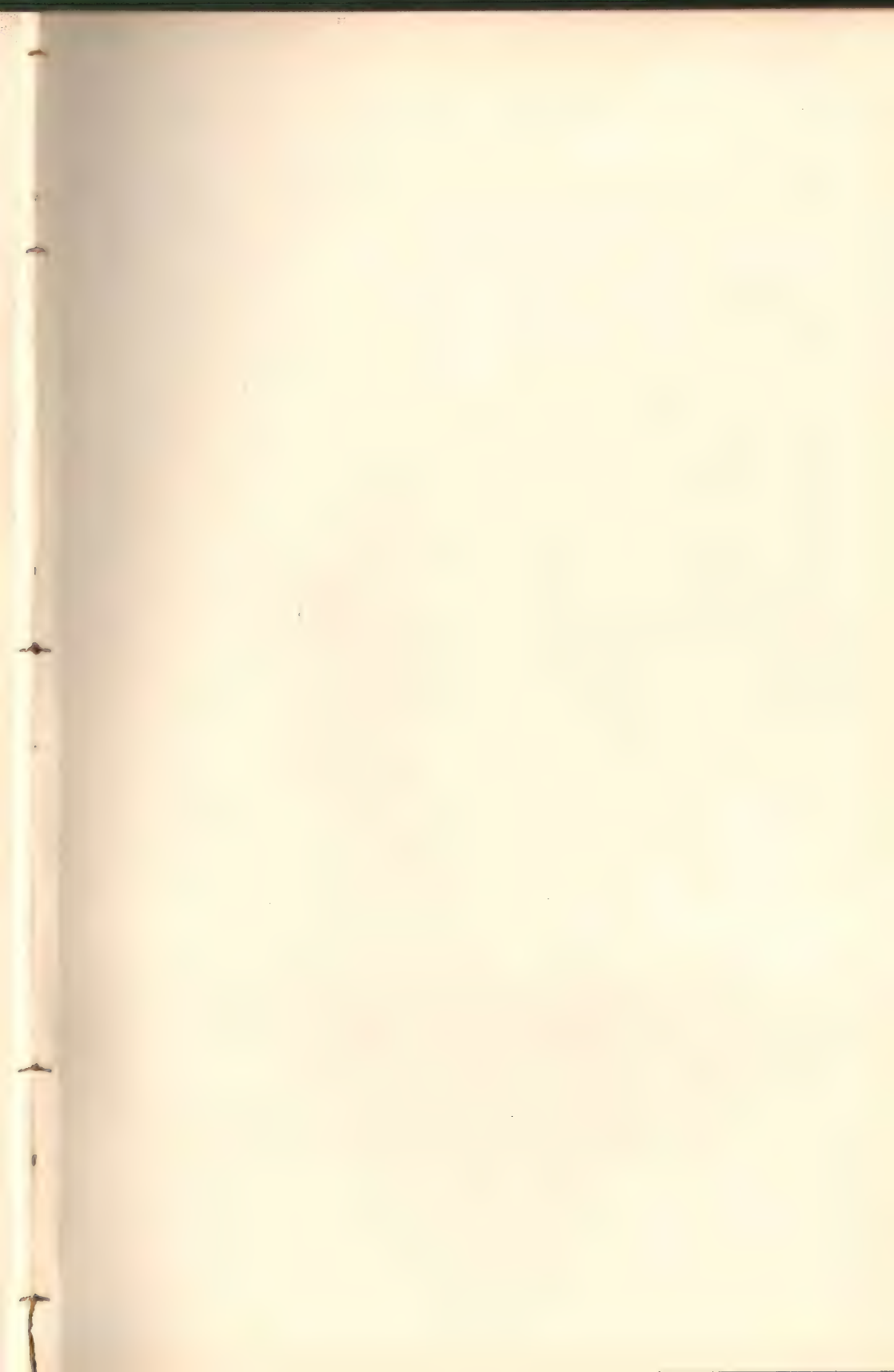
² Thus these vaults are fan-vaults in plan but not in section.



NO. 1. SHERBORNE ABBEY CHURCH. QUIRE VAULT
(From the Transactions of the Royal Inst. of British Architects, 1877.)



NO. 2. SHERBORNE ABBEY CHURCH. NAVE VAULT.
(From the Transactions of the Royal Inst. of British Architects, 1877.)





SHERBORNE ABBEY CHURCH. S. QUIRE AISLE.

ribs of regular form¹ were abandoned. This was done in the vaults of the transepts of Tewkesbury abbey which date from the second half of the fourteenth century (plate v, no. 2). The transverse ridge ribs of these vaults rise in a zig-zag line from the apex of the wall arch to the longitudinal ridge rib, which, as yet remains level and straight.

Here the arched ribs settle the shape of the ridge ribs, and not vice versa, and all of them might have been worked to the same curve, which would have produced a fan-vault without tracery; but the ribs are of different curves and the effect of these vaults is tangled and irregular, for there is nothing except a very slender ridge rib to bind the design together.

The tracery of the fan-vault was undoubtedly suggested by the patterns formed by the ribs of the lierne-vault, a West of England invention which was probably introduced for the first time in the vault of the eastern limb of Bristol abbey church, c. 1300. This vault is of simple design; the Tewkesbury lierne-vaults are far more complicated and the panels of the vault of the quire are even cusped, and ribs curved on plan are introduced. The practice of increasing the number of ribs towards the top of the fan-vault can also be traced from the early fourteenth-century vaults at Tewkesbury and Gloucester. The quire vault at Tewkesbury springs from very slender shafts, and there is not room on the capitals for all the ribs. This difficulty is solved by corbelling off the lesser ribs at the top of the springer, which is built in solid stone as usual (plate v, no. 1). The result is not particularly graceful, but examples occur even in continental work, as at Alençon (Nôtre Dame). In the transept vaults at Tewkesbury the carved corbels are combined with small cusped arches with much better effect. This was also done at Gloucester in the vault of the north transept, which was finished about 1377, where the corbels are replaced by uncusped ogee arches and the springers bear a striking resemblance to fan-vault conoids, though they are not symmetrical in form.

¹ At the end of the thirteenth and first part of the fourteenth century the longitudinal ridge rib is almost always straight, while the transverse ridge rib

is either horizontal or rises from the apex of the wall rib to the ridge in a straight or curved line.

It is not unlikely that interesting examples of the transition from the lierne-vault to the fan-vault have been lost in the destruction of the abbey churches of Winchcombe, Cirencester and Evesham. Otherwise it is difficult to account for the fact that, in spite of the advanced character of the lierne-vaults of Tewkesbury and Gloucester, there is no instance of the application of the principles of the fan-vault to the high vault of a great church of an earlier date than those of the quire (plate vi) and aisles of Sherborne abbey church in Dorset, which were not erected until after the fire of 1446. They must have been designed some years before, for the vaulting shafts, which bear the marks of the fire, are certainly intended for a fan-vault, and the arches of the windows of the clerestory and the east window are struck with the same radii. There would have been no necessity to do this had a lierne-vault been intended.

The main ribs are bold, separate from the panels, struck from the same centres and spaced at equal angles with one another. They multiply as they rise like those of the transept vaults of Gloucester and Tewkesbury. The tracery between the main ribs was certainly inspired by the little vaults of the Tewkesbury chantry chapels and the cloisters of Gloucester, but it does not lie on the surface of a conoid. It lies on a plane of single instead of double curvature, and therefore the conoids are not circular on plan but polygonal.¹ Each bay is a marked oblong, and the conoids (strictly pyramidoids) intersect with one another, giving a domical form to the vault. The design of the tracery is exceedingly fine and the intersection of the conoids is very cleverly masked. Unfortunately the curve of the ribs is much too flat. It is easy to see how this occurred. The six-light clerestory windows are wide, and it was necessary to keep the springing of the arch rather high to get a good proportion in the lower lights. Had the arches been made more acute the clerestory walls would have had to be made higher, and this would have dwarfed the tower, besides increasing

¹ I consider the vaults of Sherborne to be fan-vaults because: (a) the alternate ribs are of the same curvature; (b) they are spaced at equal angles with one another; (c) as in other fan-vaults the shape of each

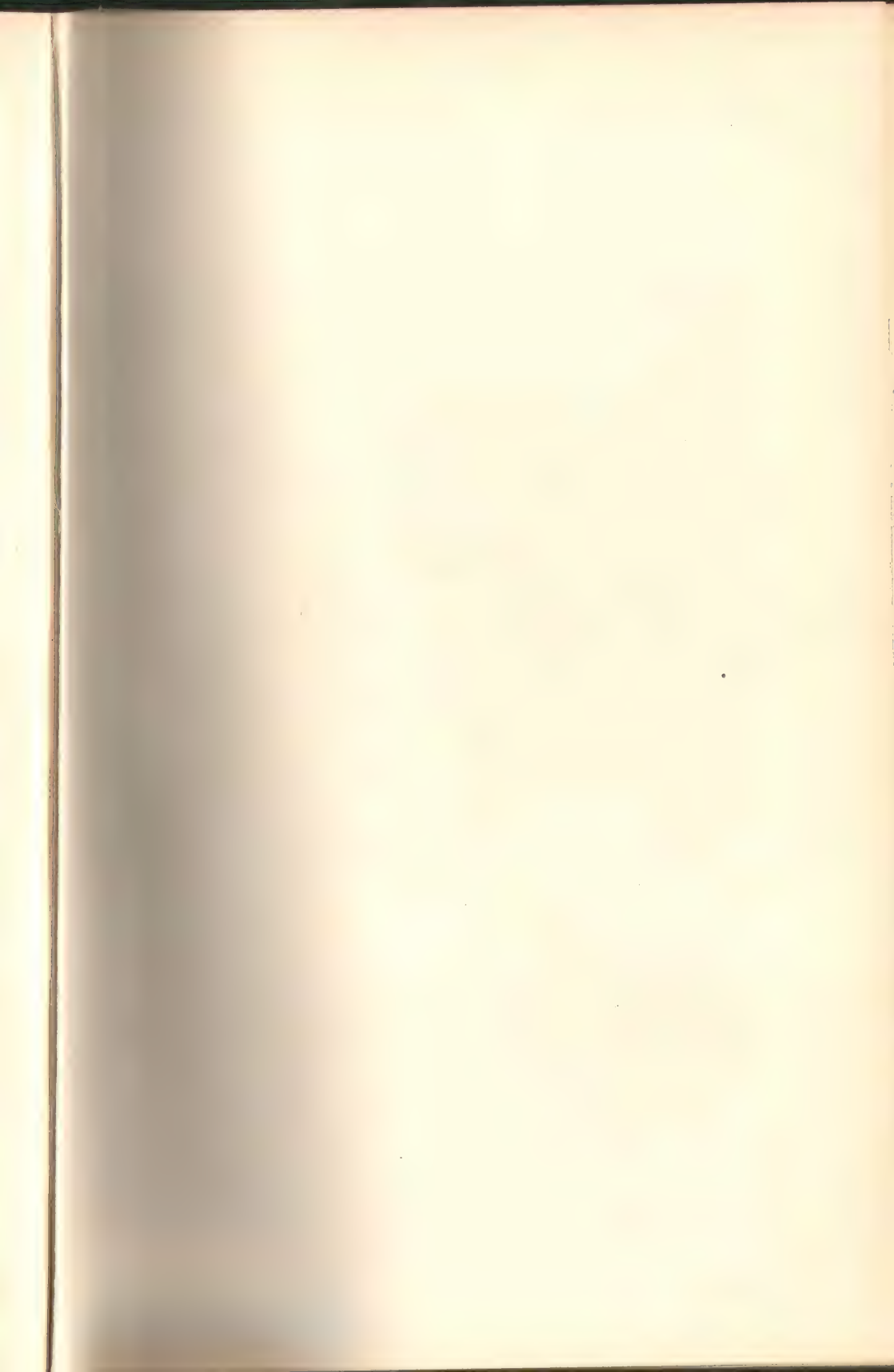
bunch of ribs was evidently considered of more account than the curve of each individual rib (as in other vaults); (d) the lierne ribs are normal to the surface of the vault and do not lie in a vertical plane.

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PLATE VIII.



SHERBORNE ABBEY CHURCH. WYKEHAM CHAPEL.





SHERBORNE ABBEY CHURCH. NAVE.

the cost of the work. The vault of the tower is continuous with that of the quire save for a short section of panelled barrel-vaulting, marking the position of the eastern tower arch. The design is similar but the tracery is adapted to the square plan and a circular hole for the bells is provided.

The vaults of the quire aisles (plate vii) and ambulatory is of similar character, but simpler in design, though the effect is very rich. Each bay is separated from the next by a short section of barrel-vaulting, panelled to harmonise with the design of the fans. These are inserted to allow for the width of the clusters of shafts which run past the pier arches to support the arches of the clerestory windows and the vault of the quire. The vaults of the Wykeham (plate viii) and Sepulchre chapels are probably contemporary with the vaults of the quire. The conoids of the former, which is of small span, are separate and bounded by a circular rib, while the spandrel is horizontal. Thus it reproduces the form and design of the vault of the lavatory of Gloucester abbey, but, being on a larger scale, it is constructed with separate ribs and panels.

The vault of the lady chapel of Canterbury cathedral church (the "Deans' chapel") 1449-68 shows that the East of England was slow to take advantage of the improvements introduced by the masons of the West.¹ Though of fair span, eighteen feet, it is planned in square bays with separate conoids and apparently domed spandrels, like the vault of a small chantry chapel, and the design of the tracery is very commonplace. There is an interesting solution of the difficulty of fitting the windows into the lunettes, while keeping large piers between them. A broad, flat, decorated with quatrefoils, runs right round the windows, connecting them with the vault.

The nave of Sturborne abbey church was not rebuilt, but remodelled, the work being commenced under abbot Raman about 1475. The high vault (plates vi and ix) is similar to that of the quire, but several improvements are introduced. The bays are narrower and the clerestory windows are of five lights; these could be

¹ The eastern side of Maidstone church are believed by Mr. F. Bond to have been intended to receive fan-vaults.

acutely pointed without raising the clerestory walls unduly, and the curve of the vault is more satisfactory than that of the quire. The wall arches are very slightly stilted, so as to get a larger window, for the designer of the Sherborne vaults was not the man to tie himself up to a formula. As at Canterbury a traceried splay frames the windows. In itself this is a great improvement on the quire vault. The pointed arch is more pleasing than the almost semi-circular transverse arch of the quire vault, and the design of the tracery is more beautiful and harmonious. Unfortunately the old walls were merely recased and the great shafts rising from the very floor of the quire to the capitals of the vault were replaced by slender clusters of columns, with little projection from the general wall-face, and corbelled off at the string course below the clerestory windows. The vaults of the nave aisles are simple lierne-vaults with all their ribs struck with the same radii, making equal angles with one another and multiplying as they rise in the manner of a fan-vault. They combine in an extraordinary way the characteristics of the two main types of fifteenth-century vaulting. The vault of the north transept (plate x) appears to be coeval with that of the nave. The plan is an almost exact square and the tracery is even more beautiful. There is also an interesting vault over the chapel of St. Catherine on the south side of the church. The spandrel is filled in with lierne ribs which only approximately continue the surface of the conoids (fig. 2).

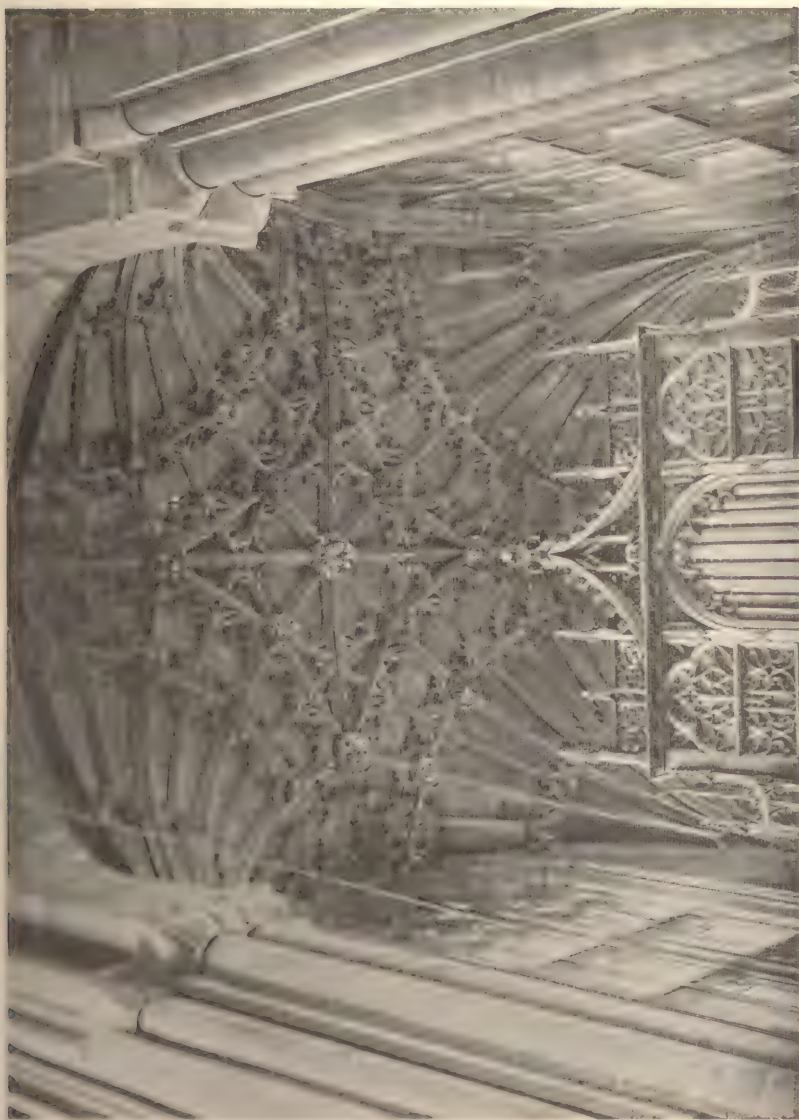
These fine vaults were copied in the transept and tower of the neighbouring abbey church at Milton Dorset, c. 1481, and in the beautiful cloister lady chapel at Wells, now destroyed,² but no further instances of the use of the fan-vault on a large scale occur until some years later. However, several small fan-vaults of great beauty and originality of construction were built towards the end of the fifteenth century. Bishop Stanbury's chapel at Hereford, c. 1453-1474, has a good fan-vault, following the design of the Gloucester vaults. Those of the chantry chapels attached to the lady chapel at

² See Mr. Edmund Buckle's paper "On the Lady Chapel by the Cloister of Wells" (*Somerset Arch. Soc. Proceedings*, xi.)

The vault of the central tower of Wells cathedral church shows the influence of the Sherborne vaults.

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PLATE X.



SHERBORNE ABBEY CHURCH. N. TRANSEPT.

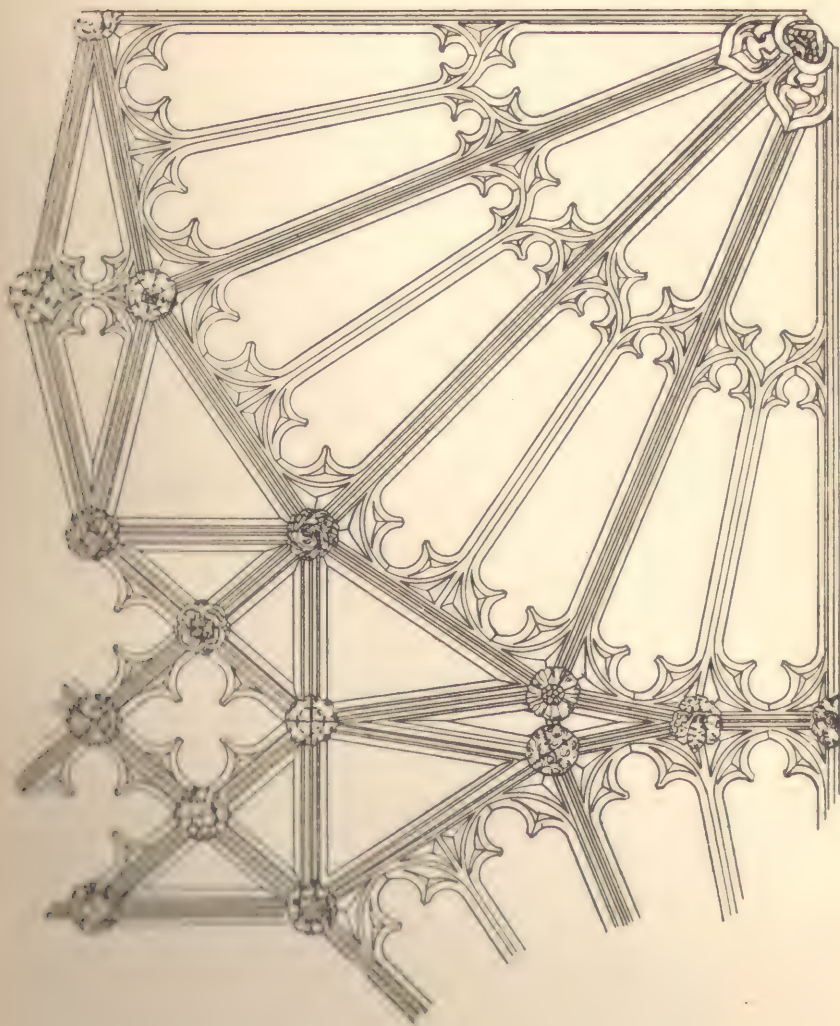


FIG. 2.

ISOMETRIC PLAN OF THE VAULT OF ST. CATHERINE'S CHAPEL, SHERBORNE ABBEY CHURCH.

Gloucester, 1457-1499, with their exquisite tracery, show an ingenious but imperfect attempt to adapt a fan-vault with separate conoids to an oblong plan. The vault of bishop Alcock's chapel, c. 1492-1500, at Ely has an early example of the pendant,¹ while that of bishop Audley's chapel at Hereford, 1492-1502, is perhaps the first instance of the application of the fan-vault to a polygonal plan. Many of the towers of Somerset have fan-vaults, and the majority date from this period, though a few are probably much earlier. The vault of the grand tower at Wrington is typical of the rest. They are generally of fair span, their conoids are not allowed to intersect, and a circular hole for the bells is always found.²

In the first thirty years of the sixteenth century so many fan-vaults were built that it is impossible to describe them in their proper order, for many were in course of erection at the same time.

The ambulatory and range of eastern chapels at Peterborough abbey church, usually known as the New Work is said to have been commenced in 1438. It was not completed until 1528, under the rule of abbot Ashton. The vault was one of the last parts of the building to be taken in hand; whether a fan-vault was originally intended is doubtful, but not impossible.

Unlike the Sherborne work, the conoids of this vault are true conoids of circular section, and the whole design is much more strongly influenced by the small fan-vaults of porches and chantry chapels. There are two square bays in continuation of each quire aisle but the five eastern bays are oblong and the conoids intersect; thus the spandrel is eliminated. The lower part of the vault is built rib and panel fashion, but the upper part, where the tracery is more intricate, is worked out of the solid. The span is no less than twenty-six feet; this is one foot more than the vaults of Sherborne. The tracery is stiffer and the intersection of the conoids is not so cleverly designed, but the vault is one of great beauty, in admirable harmony with the window tracery and wall panelling.

¹ The earliest pendants of all were probably those of the Wells chapel.

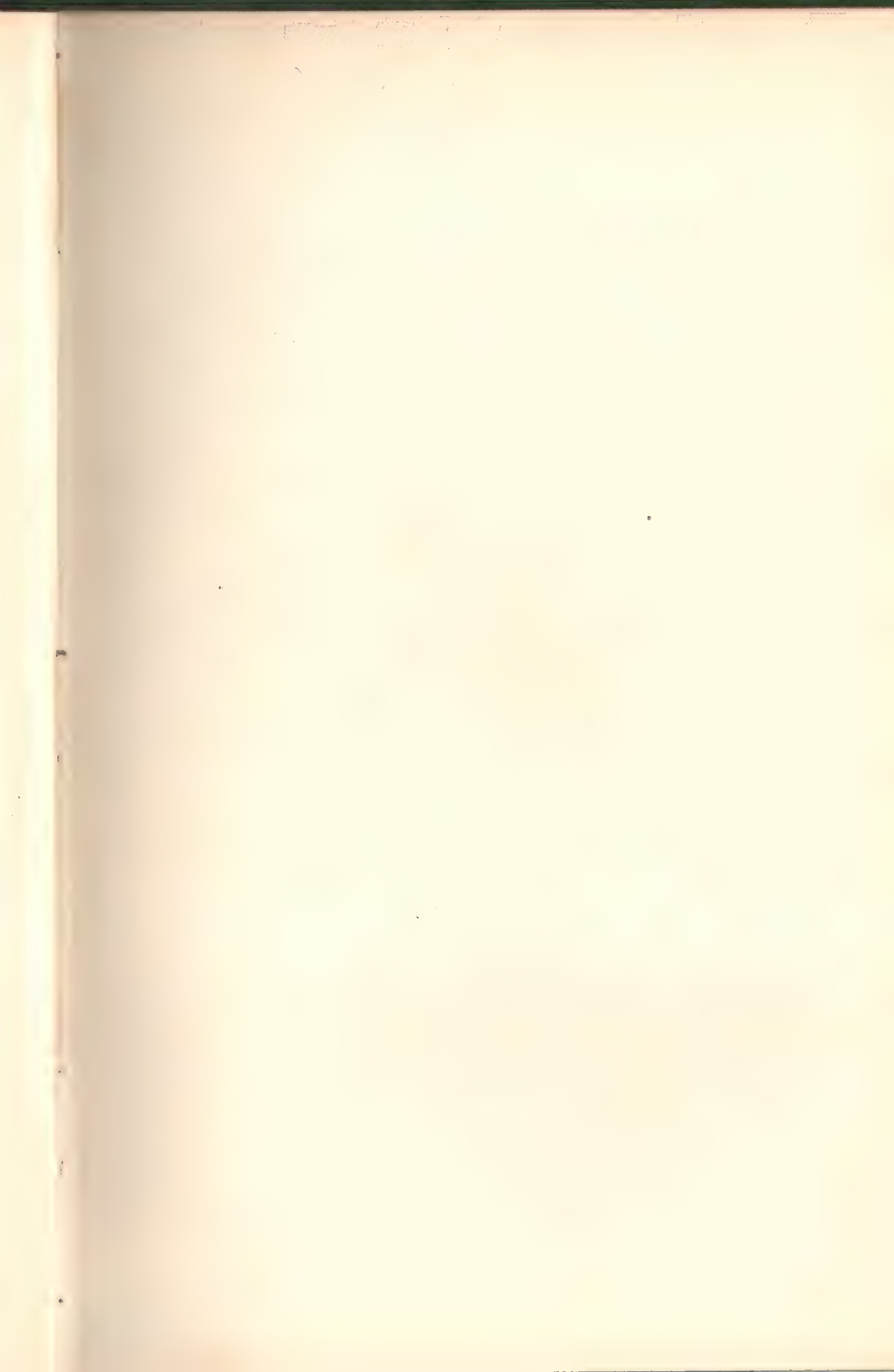
² The vault of the tower of Axbridge, Somerset, is probably quite early in the fifteenth century.



KING'S COLLEGE CHAPEL, CAMBRIDGE. HIGH VAULT.



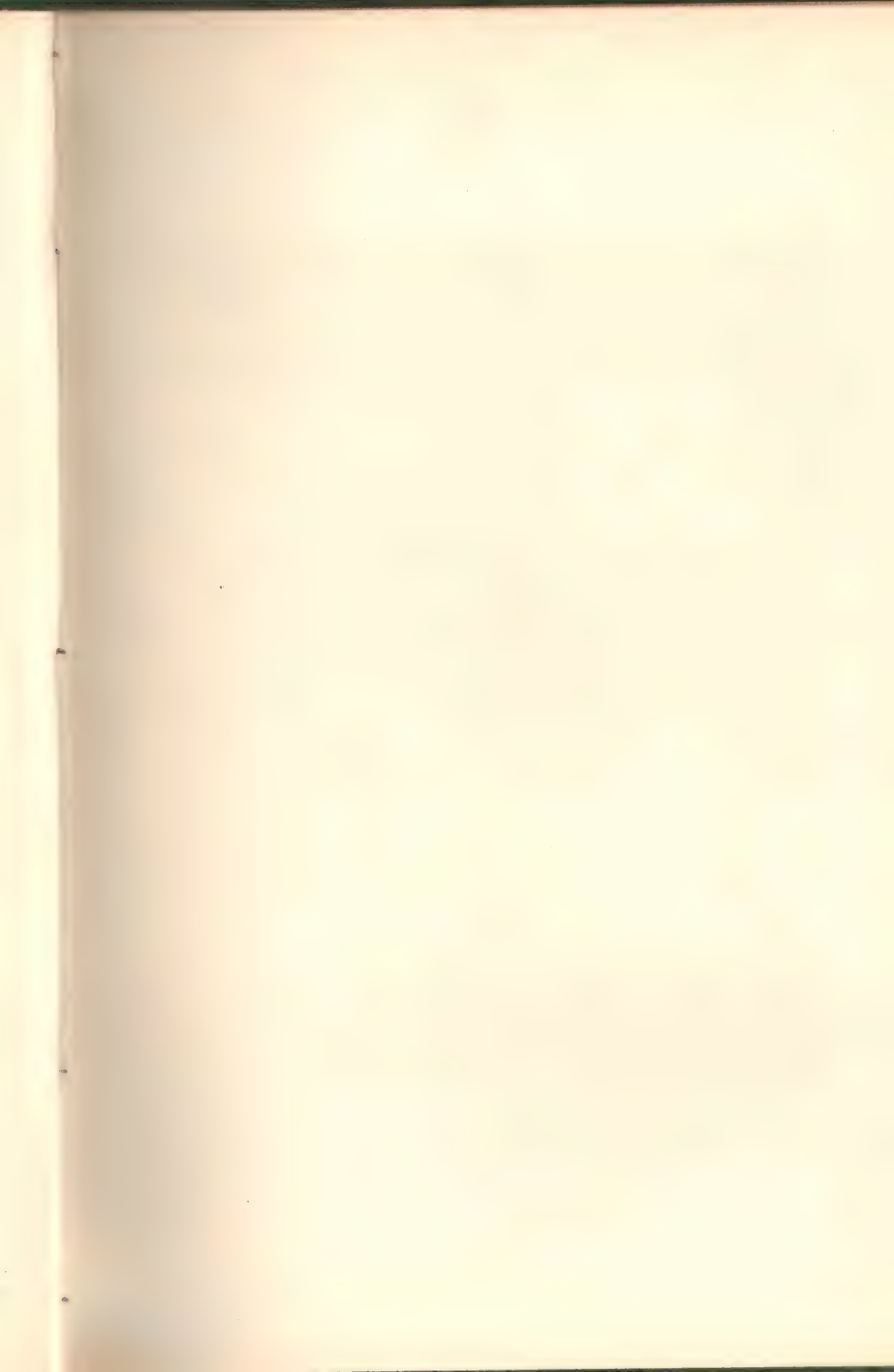
KING'S COLLEGE CHAPEL, CAMBRIDGE. SIDE CHAPEL.

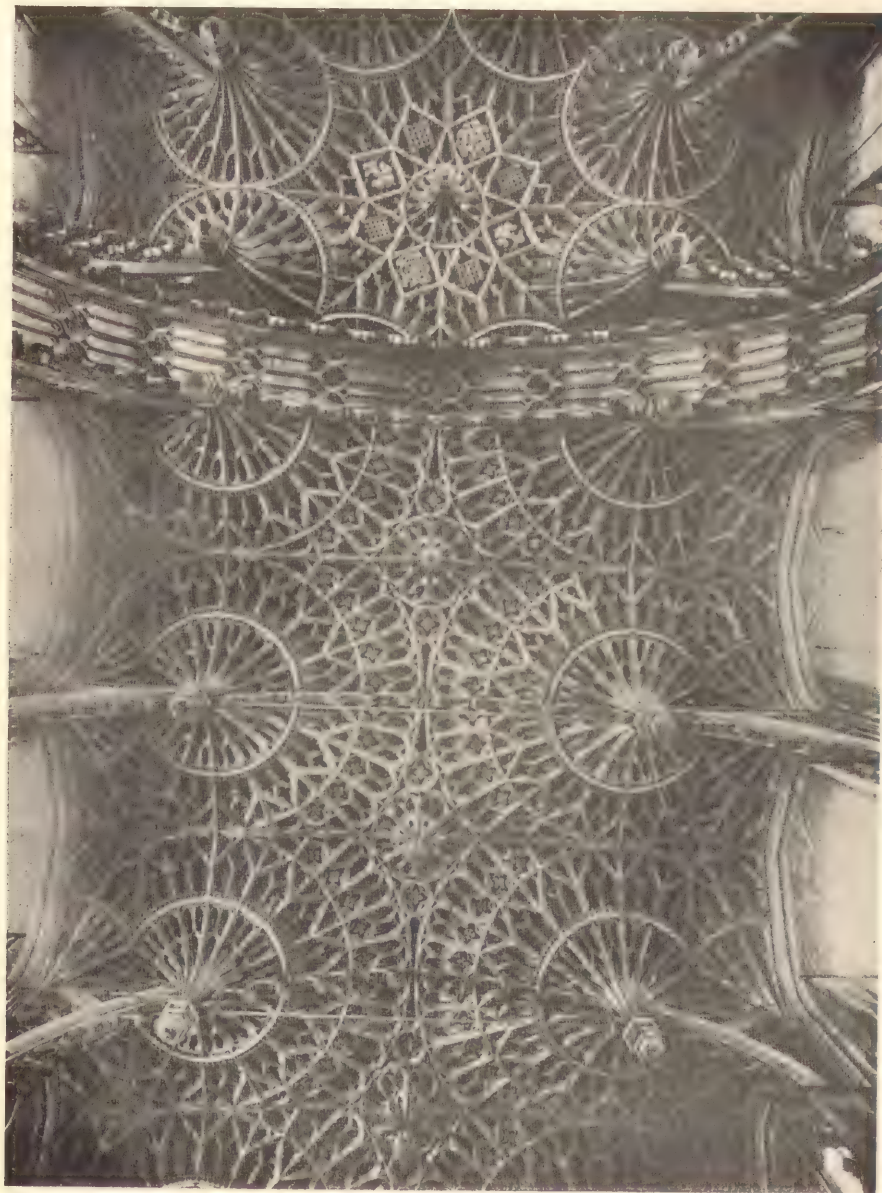




[David Weller, phot.]

WESTMINSTER ABBEY CHURCH. HENRY VII'S CHAPEL. N. AISLE.





[David Weller, phot.]

WESTMINSTER ABBEY CHURCH. HENRY VII'S CHAPEL. HIGH VAULT.

The great chapel of King's College at Cambridge was begun about the same time as the Peterborough lady chapel and the work proceeded equally slowly. It is generally agreed that this building was intended to have a lierne-vault, as is clearly shown by the section of the vaulting shafts, but in 1512 John Wastell and Henry Semerke contracted to vault the nave within three years, and the work they constructed is the largest example of fan-vaulting ever built (plate xi). The general design is almost identical with that of the Peterborough New Work. Undoubtedly they are works of the same designer.¹ The span is about forty-four feet and the construction is partly with separate ribs and panels and partly in solid work. The only important variation in the design is the introduction of massive four-centred arches between each bay. These undoubtedly add greatly to the strength of the vault, but they are not a constructional necessity. It is more probable that they were suggested by the section of the existing vaulting shafts. Several of the side chapels (plate xii) and the two porches received vaults of similar character soon after the completion of the high vault.

Another of the royal chapels, that of Henry VII at Westminster, was building in the early part of the sixteenth century. The two side chapels (plate xiii) are of moderate span, in square bays, separated by sections of barrel-vaulting as at Sherborne, and the spandrels are treated with graceful pendants. The five chapels of the apse are oblong and their conoids intersect. The vestibules to the side chapels, planned in square bays with separate conoids and flat spandrels, are exquisite examples of fan-vaulting, though small and very badly lighted.

The high vault (plate xiv) is certainly the most wonderful achievement of mason-craft in existence; the fan-vault is combined with the pendant system² which was first used in conjunction with a lierne-vault in the Divinity school at Oxford, c. 1470, and moreover the difficulty of vaulting an apse on these principles is triumphantly

¹ This resemblance is evident, not only in the design of the vault, but also in that of the windows and battlements. The dates are interesting: Peterborough commenced 1438, work abandoned until 1496, finished c. 1532; Cambridge commenced 1446,

work abandoned until 1479, finished c. 1528.

² An account of the origin of the pendant system would be out of place here, for it belongs strictly to the subject of lierne-vaulting.

surmounted. The feeling of this work is altogether different from that of King's College chapel. There is no stiffness about the tracery, which is wonderfully beautiful in detail, and the general curve of the vault surfaces is more pleasing. The pity of it is that the design is so perfect, and there is so much of it, that one fails to appreciate its

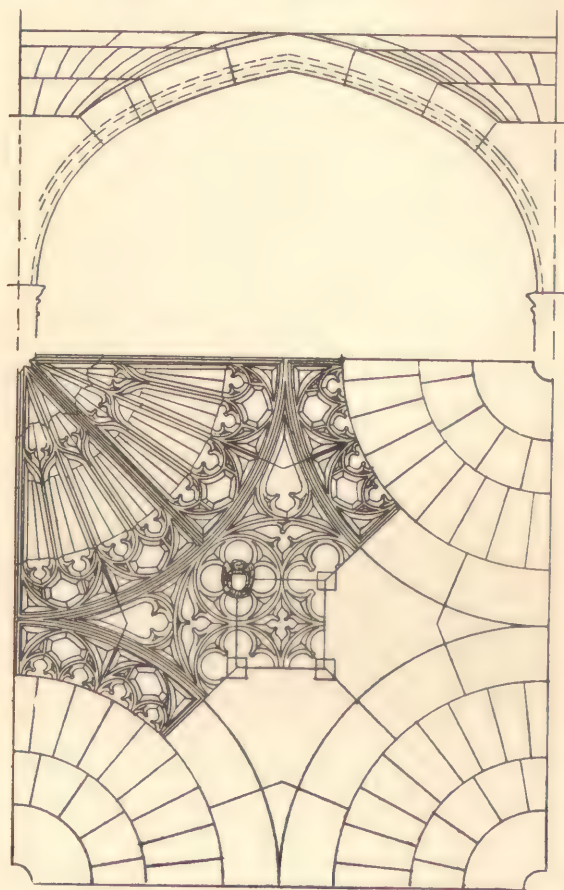
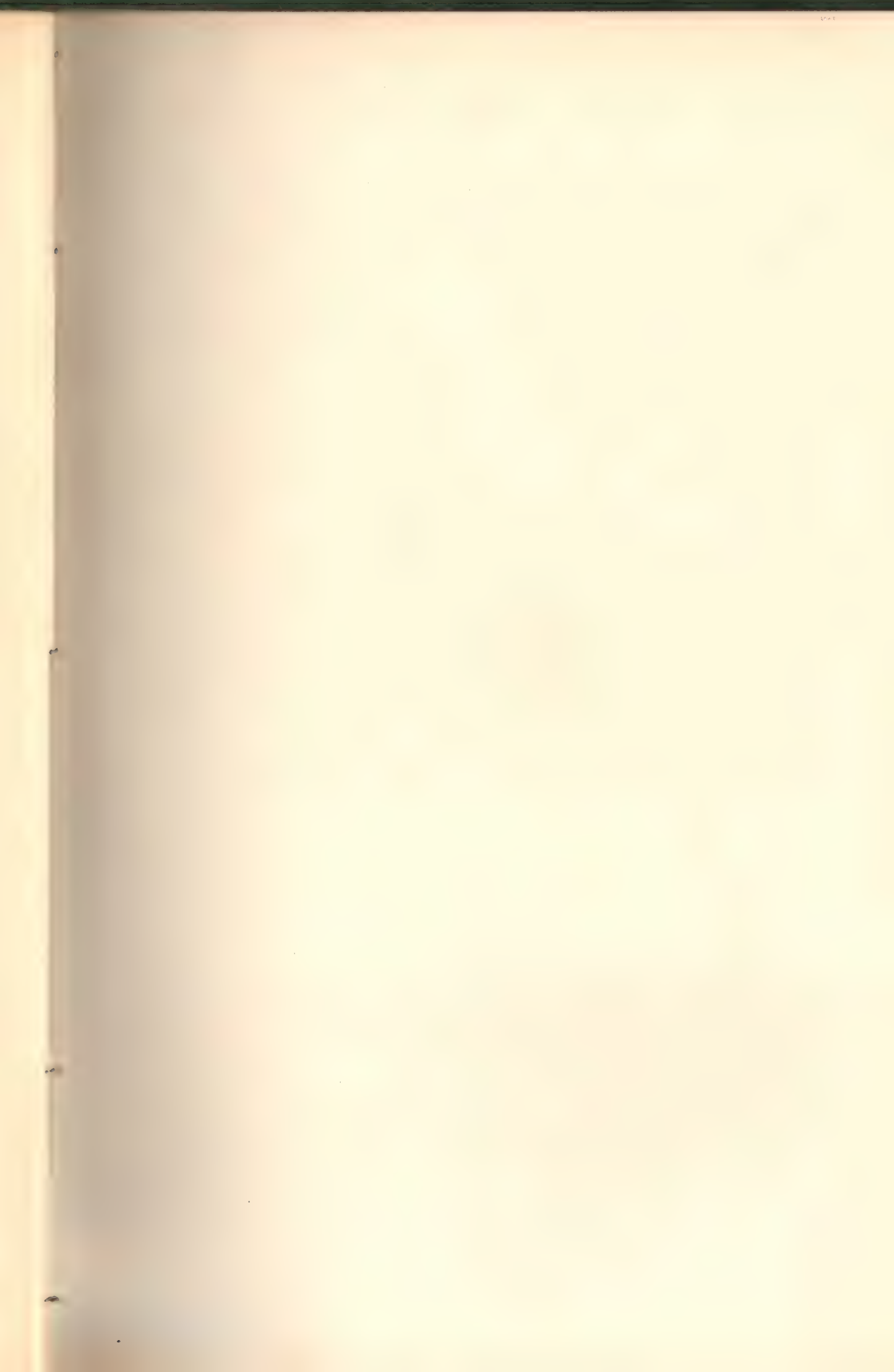
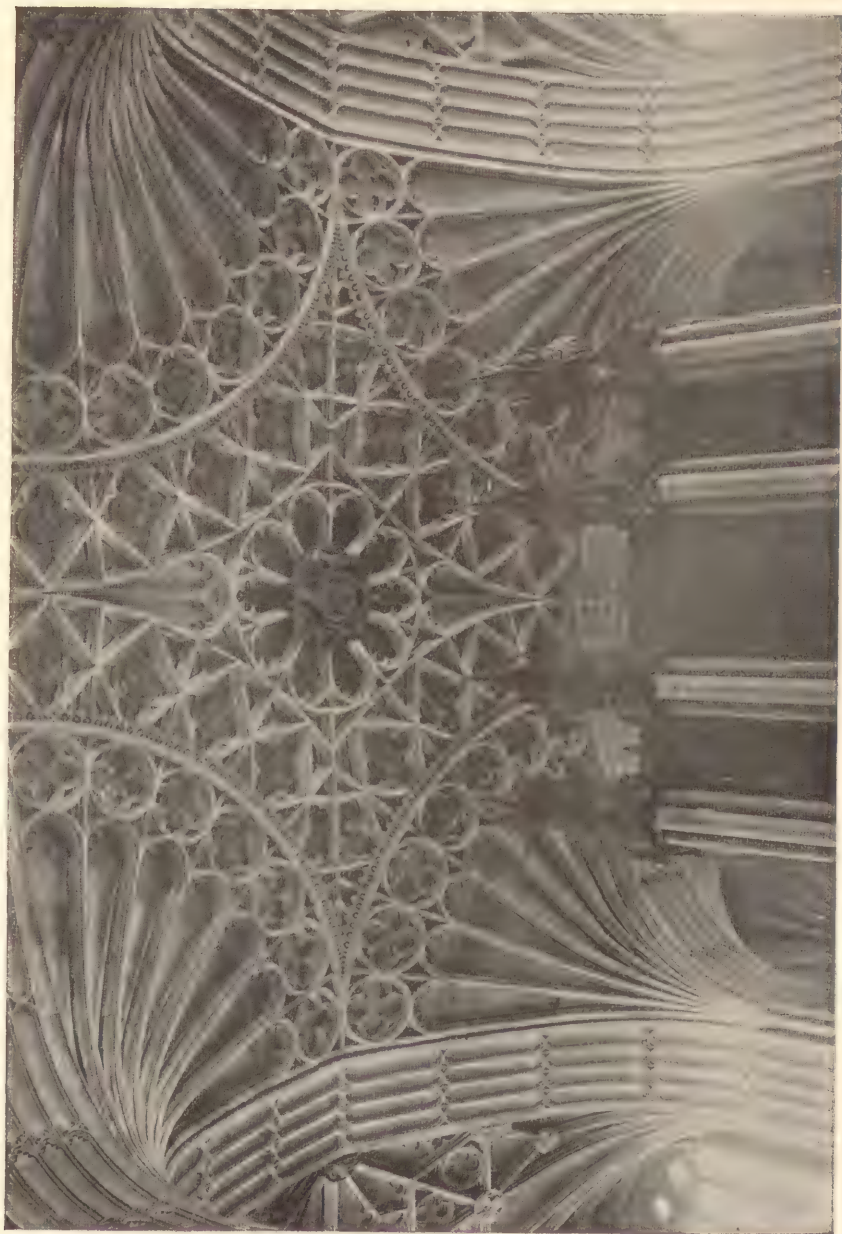


FIG. 3. PLAN OF VAULT, SOUTH PORCH, CIRENCESTER.

beauties at their proper value. Were the side chapels attached to some parish church of moderate size, their excellence would be evident, but they are scarcely noticed, for the ingenuity of the construction of the high vault overshadows everything.

The chapel of St. George at Windsor was also partly





ST. GEORGE'S CHAPEL, WINDSOR, CROSSING.

fan-vaulted at this time. The nave and quire are lierne-vaulted; but their construction has been influenced by the fan-vault, for the central part of the vaults, which are richly traceried, is worked out of solid blocks, instead of rib and panel fashion. The vault of the crossing (plate xv) is a true fan-vault of great span, oblong on plan. The conoids intersect, but leave a small spandrel with a dome, and the curve is remarkably flat. The tracery is as exquisite as that of Henry VII's chapel and the two vaults are known to be the work of the same builder. The aisles are narrow and fan-vaulted in square bays with separate conoids (plate xvi). The sections of barrel-vaulting between each, which we find at Sherborne and Westminster, do not occur. There is also a fine series of vaults over the three apsidal-ended transeptal chapels, which are instances of the application of the fan-vault to a polygonal plan.

Among the lesser examples of fan-vaulting built about this time are those of the Audley chapel at Salisbury, 1502-12 (plate xvii); the vaults now in the south porch (fig. 3) and St. Catherine's chapel,¹ 1509, at Cirencester parish church (plate xviii, no. 1), and the Lichfield chapel in All Saints church at Evesham (plate xviii, no. 2), all of which have separate conoids and flat spandrels like the early vaults. The cloisters of St. Stephen's chapel at Westminster were built c. 1526, and have good fan-vaults (plate xix). The east and west walks are planned in square bays with separate conoids and flat spandrels; the north and south walks have domed spandrels. The angle bays are not fan-vaults, but elaborate traceried lierne-vaults. A vault with a pendant in the spandrel was built c. 1513-39 in the Lichfield chapel attached to St. Lawrence church, Evesham (plate xx, no. 1). All these vaults are in square bays. The vaults of the oriel window of the hall of Christ Church, Oxford, c. 1530 (plate xx, no. 2) and the Lupton chapel (plate xxi) attached to Eton college chapel are in oblong bays and their conoids partly intersect, the spandrels being treated with solid pendants. The chantry chapel of the countess of Salisbury, c. 1529, in Christchurch

¹ These vaults were certainly taken from some other building, probably the refectory of the abbey church. Note in plate xviii, no. 1 the mouldings between the

vault and the wall and the way in which the springing is corbelled out from the wall and imperfectly finished off.

priory church has a beautiful fan-vault in two oblong bays with partly intersecting conoids. The small apsidal-ended chapel in St. Stephen's cloisters has a very lovely little fan-vault (plate xxii). The intersecting conoids make the vaulting of such apses a comparatively simple matter.

Two large chantry chapels in Devon have very fine fan-vaults of this period. The Dorset aisle on the north side of the collegiate church at Ottery St. Mary has a fan-vault planned in five oblong bays with intersecting conoids of polygonal form (plate xxiii). The work is rough but the design is excellent, and the influence of the Sherborne vaults is very strong, though the construction is not in separate ribs and panels. The large pendant bosses of simple open tracery work, finished off with Tudor roses are a striking feature. The Lane aisle on the south side of the parish church at Cullompton was built about 1510-1528; the plan is similar (plate xxiv). As at Ottery the conoids are of polygonal form, though, owing to the flatness of the crown of the vault, it has been possible to make the upper transom rib circular instead of polygonal on plan (plate xxv). The bosses of tracery work are replaced by clusters of angels with delightful effect. The arch of both vaults is comparatively acute and struck from only two centres. They must have been copied one from the other, and may have been the work of the same man.

The rebuilding of the abbey church at Bath was started about 1500. Fan-vaults of beautiful form were erected over the eastern part of the church, including the quire and its aisles, the north transept and the tower. Like Virtue's work at Windsor and Westminster their detail is refined and small in scale and they lack the boldness of the vaults at Sherborne. The high vault of the quire (plate xxvi) is thirty-one feet in span and the generating arch is fairly acute and struck from two centres. The ribs are very numerous, but of bold projection, and the tracery is interesting and well designed. As in the oblong bay of Gloucester cloisters and the crossing of the Windsor chapel the conoids only partly intersect, and a small horizontal spandrel remains, which is decorated with quatrefoiled circles. The tracery is very intricate but it has been found possible to construct the work with separate ribs and panels. The



ST. GEORGE'S CHAPEL, WINDSOR. QUIRE AISLE.





SALISBURY CATHEDRAL CHURCH, AUDLEY CHAPEL.

span of the transept vault is only about twenty feet. It is planned in two bays, one square and one oblong; the conoids of the former do not intersect, and the spandrel appears to be flat. It must be the largest example of this, the earliest of all varieties of fan-vaults. The tower has a simple vault with partly intersecting conoids, like those of the quire, but the small spandrel is pierced by a circular aperture for the bells and the design of the tracery is altogether different. The vault of the quire aisles (plate xxvii) is divided into bays of slightly oblong plan. The conoids partly intersect, leaving a spandrel masked by a well-designed pendant in the form of another small conoid. A well proportioned four-centred arch is employed in this beautiful little vault.

Bath abbey is the last of the great fan-vaulted churches, but this method of vaulting continued to be used in the colleges of Oxford, though there is a gap of eighty years between the oriel of Christ Church, c. 1529, and the gateway of Wadham College, c. 1610 (plate xxviii). This fan-vault is rather a charming specimen of Jacobean work with bold ribs and quaint pendants and strap-work. The plan is oblong and, as in the lady chapel chantries at Gloucester, the conoids are kept separate and the spandrel is widened out.

The next in date is the beautiful vault of the porch of the church of St. Mary the Virgin, 1637 (plate xxviii, no. 2). There seems to be no doubt that there was a mediaeval porch on the same site, hexagonal on plan like that of Chipping Norton, Oxon. and fan-vaulted. The splayed arches half buried in the side walls and the two lower stones of the springers, which are apparently cut out of the same blocks as the arch stones, seem to be remains of the early sixteenth-century porch, which was probably replaced by the present one because it projected too far into High Street. This is the only theory which accounts for the extraordinary way in which the vault springs, not from the angles of the porch, but from points along the sides. The upper part of the vault is undoubtedly seventeenth-century work of a similar type to the vaults of St. John's College, which were also erected by Laud at the same time. The plan is half a regular octagon and the conoids partly intersect, leaving a small spandrel which is slightly domed. The diagonal section is a semicircular arch to

suit that of the entrance. The vault of the passage from the first quadrangle of St. John's College into the second is part of Laud's building (plate xxix). It is in two oblong bays with partly intersecting conoids, the spandrel being masked by an open-work pendant of Jacobean character carved in the solid. These pendants and the absence of foliation in the circles round the top of each fan are the only signs of its late date. The passage under the garden front is similar but much more elaborate (plate xxx, no. 2). In addition to the pendant in the centre there are ten other little pendants hanging from the surface of the fans.

The vault of the gateway of Oriel College, c. 1640, strongly resembles the Wadham vault (plate xxx, no. 1). It is planned in two oblong bays with partly intersecting conoids. The ribs are large and the design stiff and heavy as in most post-reformation work.

The vault of the staircase to Christ Church hall (plate xxxi), erected in 1660, is the most famous of all the Oxford fan-vaults. The general conception is wonderfully fine, but the detail is very poor and mechanical, and shows an extraordinary lack of imagination. The same cinquefoiled arches are repeated in the two rows round the conoids, round the roses on the spandrel, and in the triangular spaces between. The ribs are very weak and have lost almost all their constructional use and the tracery is all in one order. It seems likely that the builder worked from the old small scale drawings of Wolsey's time, and supplied his own full-size details. It is planned in four slightly oblong bays with a central shaft. The central spandrel is slightly widened out to accommodate the conoids to the oblong plan and is domed. This vault and that of King's College chapel are the only two examples of the use of bold moulded transverse arches between each bay.

The vault of Tom Tower is part of Wren's work of 1689 (plate xxxii, no. 1). The detail is more interesting but a little stiff. There is a large number of shields with the royal arms and those of various benefactors, surrounded by strap-work. A massive wreath of laurels, bound with ribbons, frames the huge circular opening through which the great Tom bell was raised.

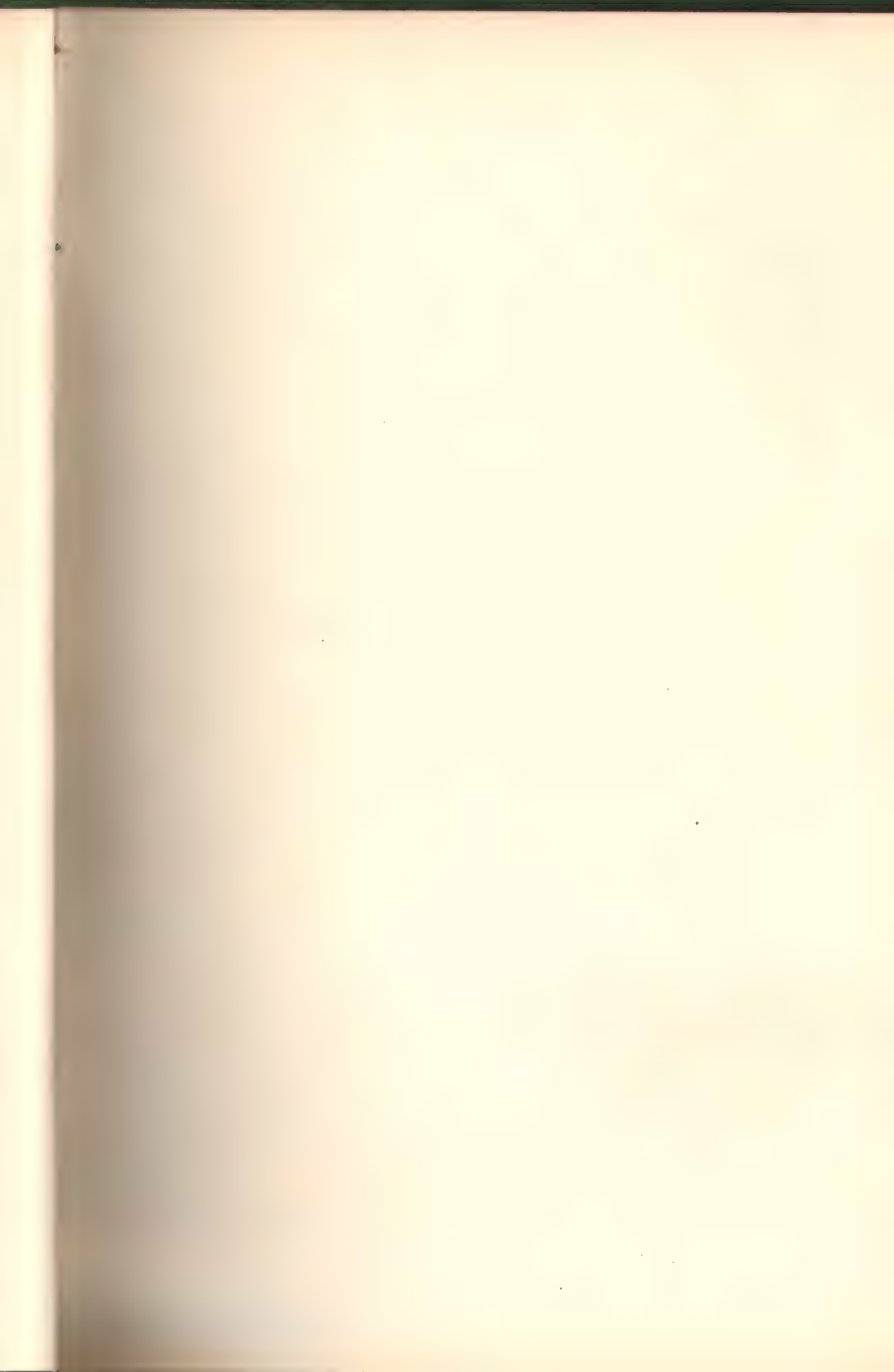
Later still are the vaults of University College gateways.



NO. 1. CIRENCESTER CHURCH, GLOS. ST. CATHERINE'S CHAPEL.



NO. 2. ALL SAINTS CHURCH, EYESHAM. LICHFIELD CHAPEL.





ST. STEPHEN'S CLOISTERS, WESTMINSTER.

They probably date from the building of the second quadrangle in 1719; the detail is very poor and wiry and the springers are badly managed. The best carving is to be found in the shields and strap-work. The vault of the older tower is in one oblong bay with intersecting conoids. The other tower (plate xxxii, no. 2) has a vault in two square bays, but the plan is not quite rectangular, owing to the curve of High Street, and so a small triangle of barrel-vaulting, panelled like the vault, is introduced to fill in the space left at each end. The spandrels are flat and have huge bosses with acanthus foliage.

Later still is the vault of the gateway of Corpus Christi College, apparently erected at the remodelling of 1817. It is more mediaeval in feeling, though rather stiff and hard, and may be a restoration of a sixteenth-century vault.

III. CONSTRUCTION.

There is no important difference between the constructional principles of a fan-vault and those of any other Gothic vault, save in a few cases where the panels are very thick and the ribs extremely small. They are simply ribbed vaults with a great number of ribs of the same curve. In the majority of cases the ribs are so numerous and form so intricate a pattern that it is easier to carve the ribs and panels out of large blocks of stone than to build up the ribs first and fill in the panels with separate pieces, though the latter method is employed in many of the larger fan-vaults (fig. 4). When the ribs are produced by sinking panels into the surface of the vault the former are not necessarily unconstructional. The most necessary qualities of vaulting are stiffness and lightness; these properties are obtained just as well when the ribs and panels are carved out of the same stones as when the ribs and panels are separate. Joints do not make the work stronger; they only render it more elastic.

Yet the ribs of the fan-vaults are frequently described as merely decorative. This is certainly true of some examples; the vault of the Despencer and Fitz-Hamon (Founder's) chapel, at Tewkesbury, Gloucester cloisters,

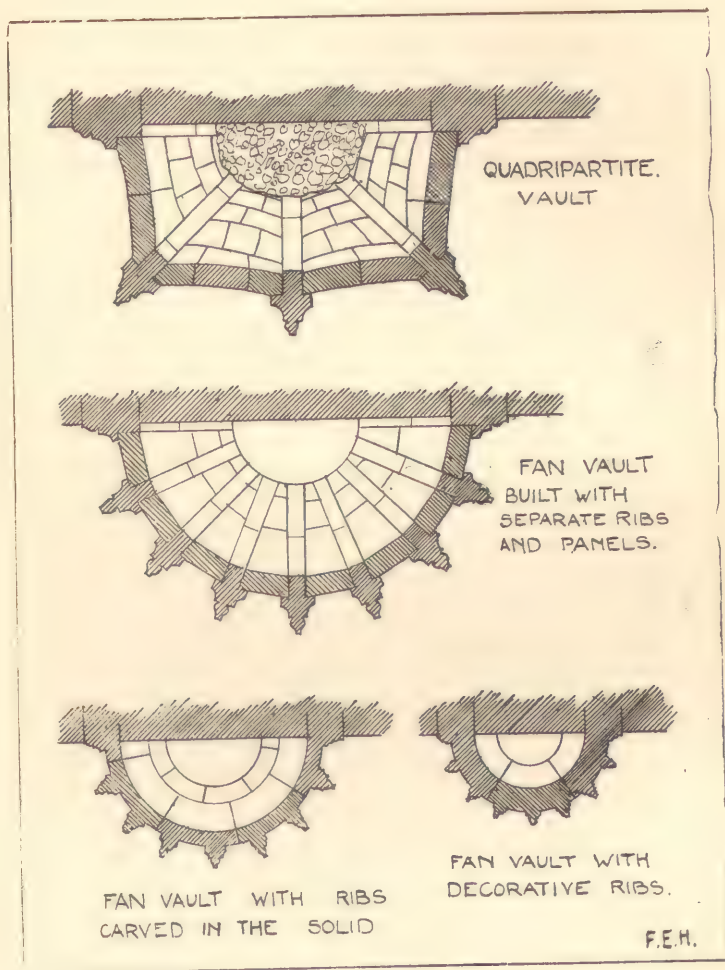


FIG. 4.

HORIZONTAL SECTIONS THROUGH THE SPRINGERS OF VAULTS,
LOOKING DOWNWARDS.

Cardinal Beaufort's and William of Waynflete's chapels at Winchester and the porch of Torbrian church, Devon,¹ are instances, but they are unimportant and of very small size. The ribs of such vaults as those of Sherborne abbey, King's College chapel, and Bath abbey, though wonderfully decorative, are as constructional as the thirteenth-century vaults of Lincoln, Wells or Westminster.

How do the functions of the ribs of a fan-vault differ from those of a thirteenth-century vault? In each case the lower portion of each springer is built in horizontal courses, projecting from the wall. This is logical, for it is only the upper part of a pointed arch that acts as a true arch²; the lower voussoirs are in reality nothing more than corbels. Then in the case of the thirteenth-century vault a wooden frame known as a centre is set up for each of the ribs to support the arch stones while they are being built. Next the panels are filled in with courses of stone, very slightly arched from rib to rib. During the actual building of the panels they are undoubtedly supported by the ribs, but as soon as they are completely filled in, the last stone wedged home and the joints flushed with mortar, they become arches, butting up against the ridge and support themselves. The permanent function of the ribs is to stiffen the vault and prevent buckling, and the popular idea that they are arched girders carrying the webs is incorrect.

Now the ribs of a fan-vault, even when cut out of the same blocks of stone as the panels, increase the thickness of the vault and consequently stiffen it, just as well as those of a thirteenth-century vault. The only disadvantage is that a fan-vault requires more elaborate centering than an ordinary ribbed vault.

An argument sometimes heard is that although the ribs of a fan-vault are in most cases in one piece with the panels, they appear to be separate from them and consequently the construction is insincere. It would be equally logical to demand that the circular shafts of a

¹ All of these examples are early and imperfectly developed, with the exception of Waynflete's chapel, which is copied from the much earlier chapel of Cardinal Beaufort.

² This is also true of a semicircular arch. In a four-centred arch this distinction between the function of the upper and lower voussoirs is marked by the different curves.

thirteenth-century clustered pier should be separate from the body of the pier. As a matter of fact, except when marble shafts are employed, these piers are built in courses and often many shafts are worked out of the same block of stone; and the sincerity of the architecture of the thirteenth century is above suspicion.

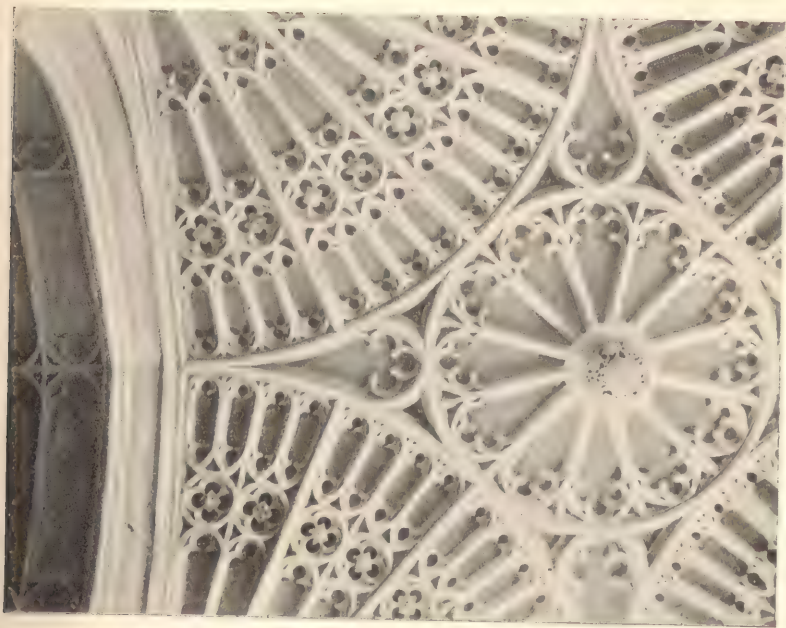
Again it is sometimes said that the ribs of a fan-vault are so small, compared with those of a thirteenth-century vault, that they can be of little use. In answer to this it may be said that the ribs of the early vaults are excessively large and that very small ribs are employed in many lierne- and fan-vaults, which are undoubtedly built with separate ribs and panels and have proved perfectly safe and stable. Of course the importance of the ribs depends not so much on their actual size as on their relative size compared with the thickness of the panels. These are generally very thin indeed, rarely more than four inches even in the largest vaults. Vaults having their panels much thicker than the projecting ribs are exceptional. In these cases the rib does so little work that the vault may be said to be ribless, like a groined vault. These small un-constructional ribs also occur in the lierne-vaults of the Fox and Wykeham chapels at Winchester.

Yet another argument remains to be disposed of: one frequently finds that a joint occurs down the centre of the rib so that one half of the rib is worked on one block of stone and one half on the other. How then can such a rib be constructional? Such joints are kept very fine, so that the section of the rib is not reduced and the two halves of the rib are cemented together so thoroughly that the joint is practically non-existent, and it is a well known fact that, provided the abutment is satisfactory, there is no stress in these joints of an arch which lie as these do in a perpendicular plane.

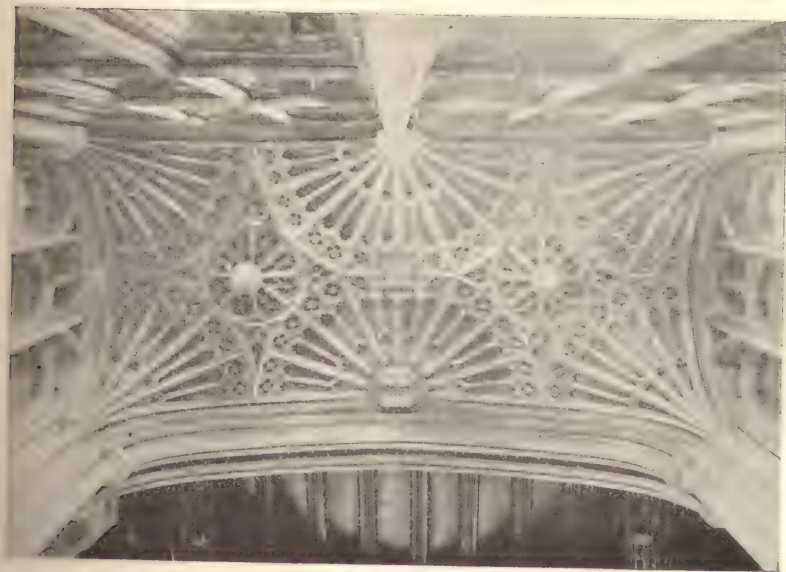
It is certain that the reason why the ribs and panels of a fan-vault were worked in the solid is that owing to improvements in the methods of quarrying and transport it was possible to get large blocks of stone,¹ and it would have been absurd to cut them up into small sections,

¹ The large size of the blocks of stone used in buildings of the fourteenth and fifteenth century, compared with the little

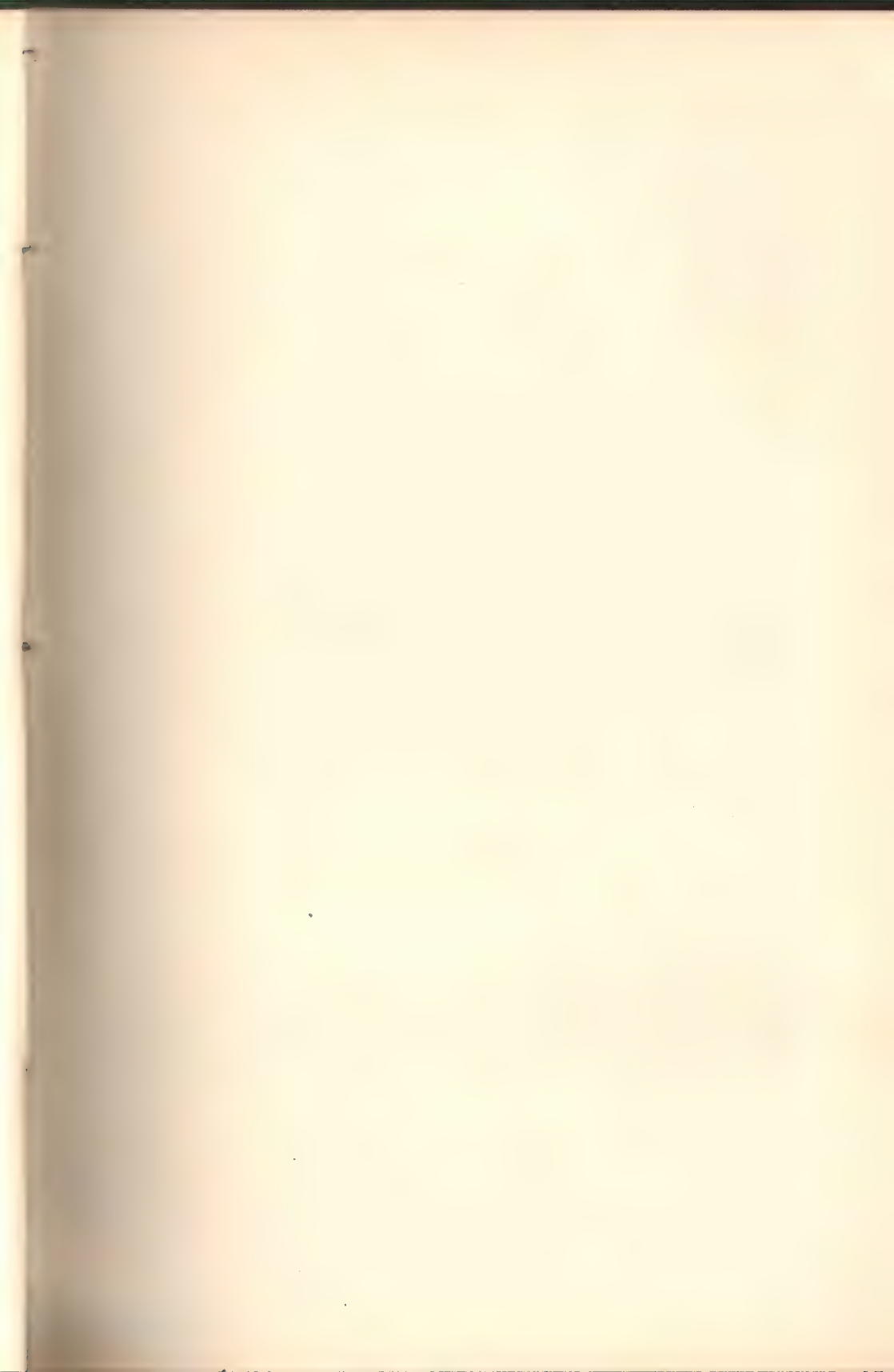
cubes which are general in Norman work, is well known.



NO. 1. ST. LAWRENCE CHURCH, EVESHAM. LICHFIELD CHAPEL.



NO. 2. CHRIST CHURCH, OXFORD. ORIEL IN HALL.





ETON COLLEGE CHAPEL. LUPTON CHAPEL.

merely to bind them together again. And these vaults, built of ashlar, could be made much thinner than the old vaults, with their large ribs and thick rubble panels; thus the thrust of the vault¹ was reduced to a minimum, and thick walls and elaborate systems of flying buttresses could be dispensed with. Besides this there was the advantage that ploughshare panels were eliminated; these were never good construction and were often a great

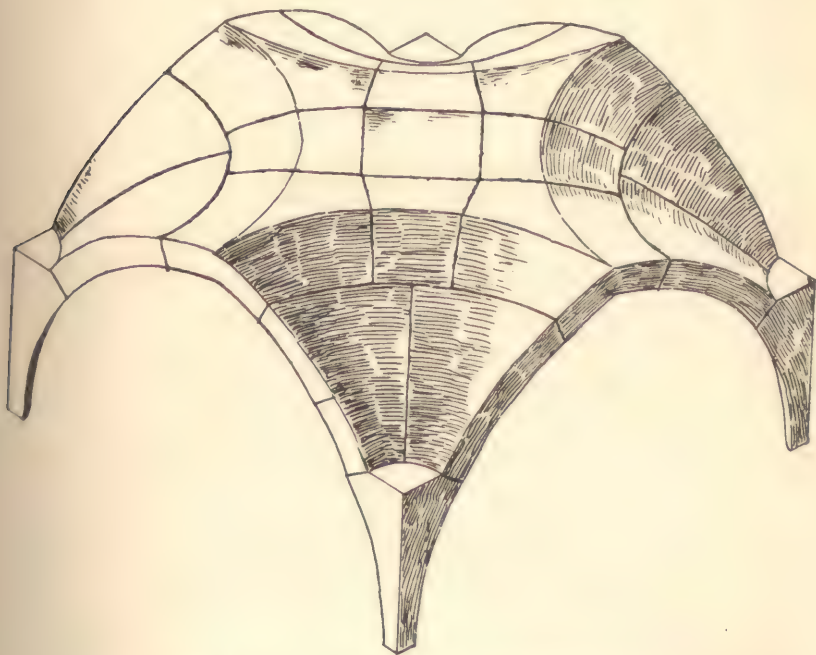
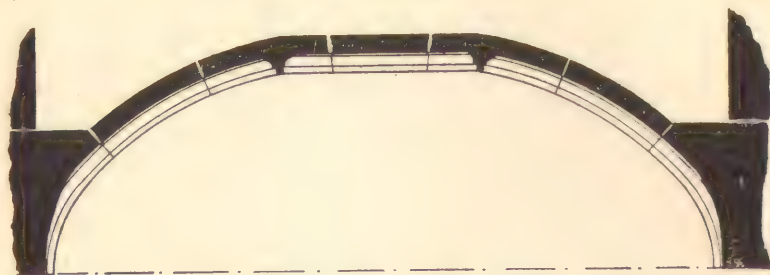


FIG. 5. FAN-VAULT WITH SEPARATE CONOIDS.

disfigurement to the vault. Moreover, in a very domical vault of the French type the thrust was not entirely concentrated at the points of support. A certain amount of thrust occurred along the side walls between the buttresses from the excessive concavity of the webs. In

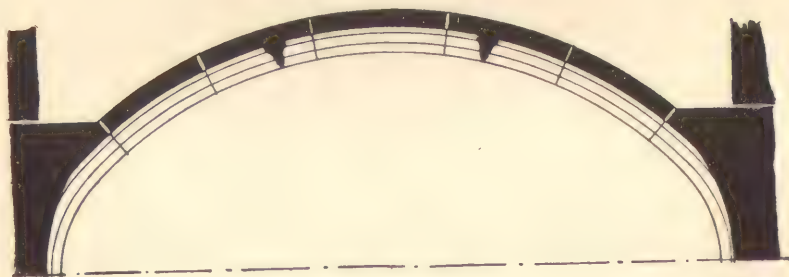
¹ This depends on two principal things besides the span: (1) the curve of the arched ribs; (2) the weight of the vault itself.



(a.) WITH FLAT SPANDREL



(b) WITH PENDANT.



(c) WITH DOMED SPANDREL.

FIG. 6. DIAGONAL SECTIONS OF FAN-VAULTS WITH SEPARATE CONOIDS.

To face page 24.

PLATE XXII.



CHAPEL IN ST. STEPHEN'S CLOISTERS, WESTMINSTER.





OTTERY ST. MARY COLLEGIATE CHURCH, DEVON. DORSET AISLE.

a fan-vault the thrust was entirely concentrated upon the points of support and the curve of the tranverse ridge rib, when one was used, was settled by the arched ribs which supported it and it was not in any sense an obtuse arch between the apices of the clerestory windows as in the case of the domical vault without intermediate ribs.

Turning from the comparison of the general constructional principles of the fan-vault with those of the older method of vaulting, let us consider next the construction of the various varieties of fan-vaulting.

The first class of fan-vaults is planned in square bays. The general surface of the vault takes the form of conoids, butting up against a flat ceiling or spandrel (fig. 5). In this case the latter is built with radiating joints, and transmits the thrust of the ribbed conoids from one to the other, acting as a key-stone. This form of vault gives a diagonal section of broken curve (fig. 6, a) which is quite safe on a small scale, but decidedly risky if employed in a large vault. And if the generating arch is acute, as in the Tewkesbury chapels and Gloucester cloisters, the effect is that of large corbels supporting a flat diamond-shape slab.¹ This effect can be reduced to a minimum by employing a four-centred arch, instead of a pointed one, and this was almost always done in later examples of this type.²

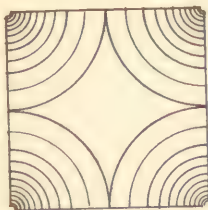
There are three other ways of treating the spandrel. If the vault is beneath a tower an aperture through which to raise and lower the bells is necessary; this may be provided for by forming a circular hole in the spandrel, framed by a stout rib, jointed like an arch, which transmits the thrusts of the conoids from one to the other just as well as if the spandrel were solid. Thus the flat portion of the vault is eliminated, save for four small triangles.³ If no aperture is required it is possible to cover it in with a dome (fig. 6, c), and if the curve of the dome

¹ Mr. E. S. Prior is mistaken when he says that this is actually the case in the Tewkesbury chapels.

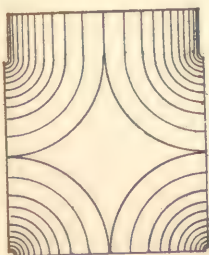
² All Souls passage, Oxford; Stanbury chapel, Hereford; St. George's chapel, Windsor, aisles; Cirencester chapel and porches; Ottery St. Mary, N. porch; Audley chapel at Salisbury; porches and vestry at Maids' Moreton, Bucks; Fairfield

porch, Gloucestershire; Lichfield chapel; All Saints, Evesham; St. Stephen's cloister, and many others.

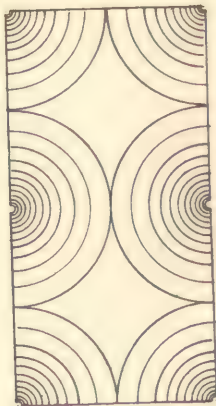
³ Examples of this are the vaults of Wrington, Axbridge, and many other Somerset towers. In the vault of the tower of Highworth, Wilts, the rib forming the aperture is much larger than the others.



CIRENCESTER. N. PORCH.



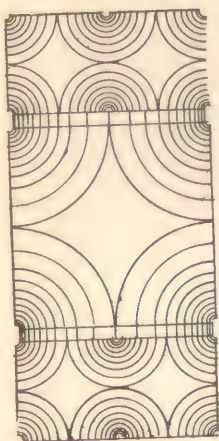
TOR BRYAN. DEVON.
S. PORCH.



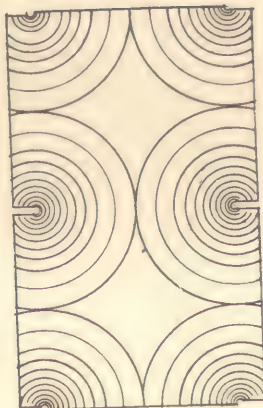
HEREFORD
STANBURY CHAPEL.



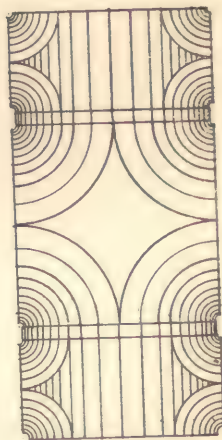
CIRENCESTER. S. PORCH.



WINCHESTER.
BEAUFORT CHAPEL



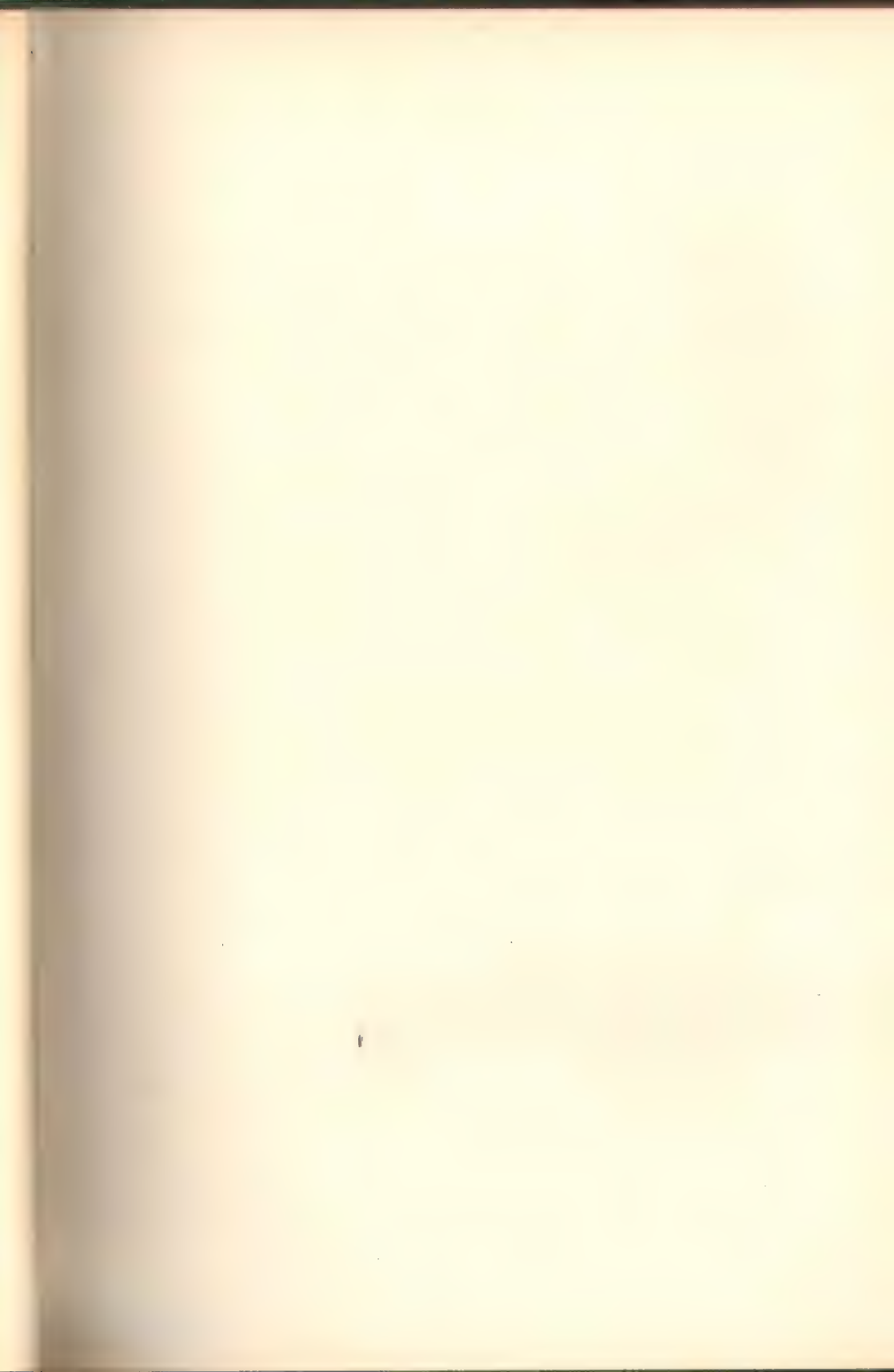
TEWKESBURY.
DESPENCER CHAPEL.



WINCHESTER.
WAYNFLETE CHAPEL.

FIG. 7.

THE APPLICATION OF SQUARE BAYS OF FAN-VAULTING TO OBLONG PLANS.





CULLOMPTON CHURCH, DEVON. LANE AISLE.

is a continuation of the curve of the ribs of the conoid, the flat-crowned diagonal arch is done away with. This is not a very usual solution.¹ If a particularly elaborate effect is desired the spandrel may be masked by a pendant² (fig. 6, b). This may be constructed by dropping down a long and slender keystone and making small arched ribs spring from the lower end of this to abut against a circular rib inscribed in the spandrel;³ or it may be worked out of a large stone, hollowed out to reduce the weight, and may itself be the key-stone.⁴

All these vaults have separate conoids which are perfect quadrants of circles on plan, the radius of the conoid being equal to half the side, and consequently the bays are square. But buildings are more often oblong than square, and there are devices by which square bays of fan-vaulting may be adapted to an oblong plan (fig. 7). If the length is some multiple of the breadth the vault may be planned in several square bays, but this is often impossible. In the vaults of St. Catherine's chapel and the south porch at Cirencester the plan is a little over three squares long, and the south bay, the design of which is unmodified, is cut off short in a most ungraceful manner. The solution adopted in the vaults of the two Tewkesbury chapels is similar; the width is a few inches more than half the breadth and so the springers are brought forward, pendant-fashion. This leads to an unsightly intersection of the tracery with the side wall.

In very small vaults it is possible to get over the difficulty by widening out the flat spandrel, but this makes the vault dangerously obtuse. One may cite as examples the beautiful little vaults of the side chapels of the lady chapel at Gloucester and the seventeenth-century vault of the gateway of Wadham College, Oxford (plate xxviii). A more obvious solution is to eke out the fan-vault with a section of barrel-vaulting of the same curve, treated to

¹ Examples may be seen in St. Stephens' cloisters, the lady chapel at Canterbury and the porch of Hillesden church. The latter is a modern restoration.

² The only possible excuse for the pendant is that it weights and steadies the vault. Brunelleschi among others believed that such a weight at the crown was necessary for the stability of a pointed arch, and

consequently put a heavy stone lantern on the dome of Sta. Maria dei Fiori.

³ The only existing example is Alcock's chapel at Ely, but pendants of this kind were used in the cloister lady chapel at Wells.

⁴ The aisles of Henry VII's chapel at Westminster and the Lichfield chapel at St. Lawrence, Evesham.

harmonise with the fans, as in the porch of Torbrian church, Devon (fig. 8). This device is useful in many cases. When the piers are very broad and their thickness is restricted, a section of barrel-vaulting may be inserted between each bay of the aisle vault as at Sherborne abbey church and

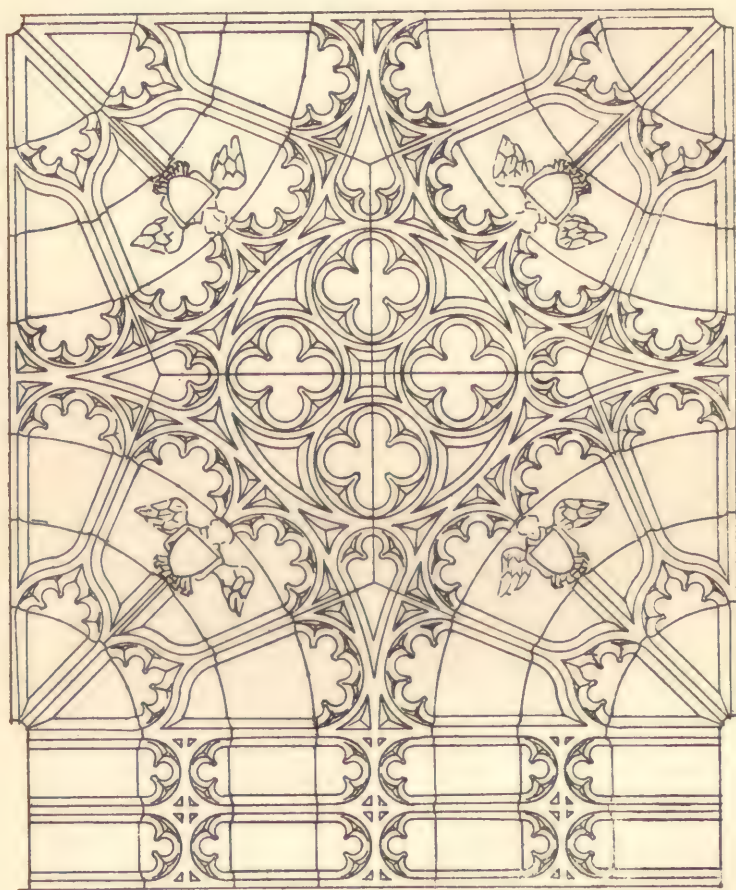


FIG. 8. PLAN OF VAULT, SOUTH PORCH, TORBRIAN, DEVON.

Henry VII's chapel at Westminster (plates VII and XIII), and when the respond of a pier arcade is some distance from the end wall as at Bath a difficulty is met with that can be easily surmounted by the use of the barrel-vault; the allowance for the thickness of the walls necessary at the

angles of cloisters is easily made if this device is adopted as at Gloucester (plate xxxiii), Tewkesbury and St. Stephen's, Westminster. It may even be employed to adapt a fan-vault to a skew plan as at University College, Oxford (plate xxxii).

But it is difficult to adapt the fan-vault with separate conoids to a polygonal plan. The length of the side of

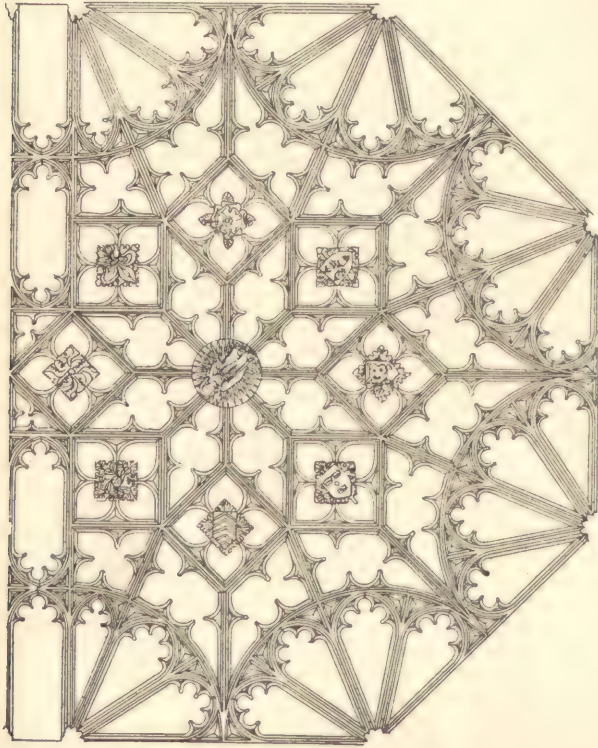


FIG. 9.

PLAN OF VAULT, AUDLEY CHAPEL, HEREFORD CATHEDRAL CHURCH.

a polygon, on which the size of the conoids depend, is so small in comparison with the breadth that a huge spandrel is left which is too wide for a flat ceiling with radiating joints, while a pendant or a large aperture is obviously impossible. The only solution is to cover the spandrel with a dome, leaving little flat triangular spandrels,

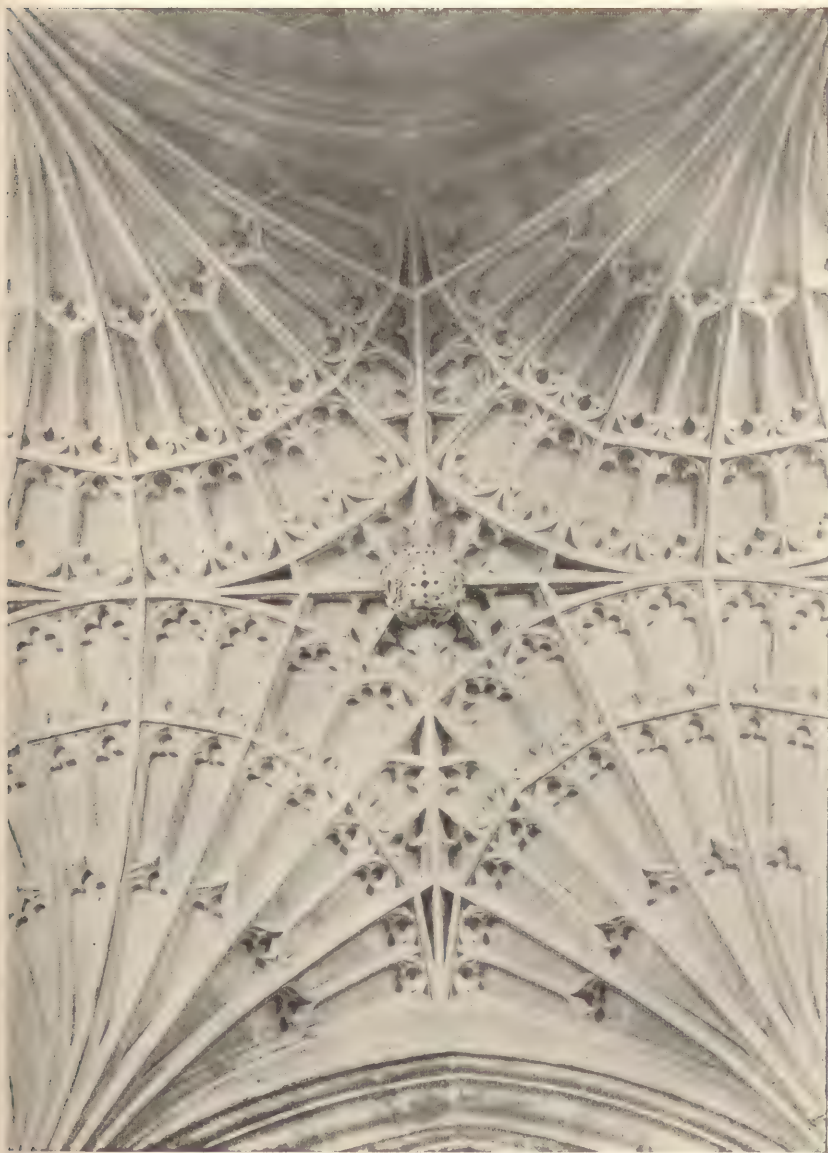
as in the vault of the Audley chapel at Hereford, which has had to be suspended from the roof timbers (fig. 9). The three small apsidal chapels of St. George's chapel, Windsor, are also of this form.

The second great class of fan-vaults includes those whose conoids partly intersect, but still leave a small central spandrel. The radius of the circular rib bounding the conoids is usually equal to half the greater side of



FIG. 10. FAN-VAULT WITH INTERSECTING CONOIDS.

the bay. In the case of a square bay the radius would be greater than half the side, but all the examples are in oblong bays. This is a more advanced type of fan-vault altogether, for it can be adapted with ease to any shape of plan, without the use of barrel-vaulting. The earliest instance occurs in a bay of the cloisters of Gloucester, where the small spandrel is flat (plate III). The high vault of the choir of Bath abbey church is also built on this prin-



CULLOPTON CHURCH, DEVON. LANE AISLE.

ciple (plate xxvi). As in the case of the fan-vaults with separate conoids, it is possible to treat the central squandrel with a circular aperture as in the vault of the central tower of Bath abbey ; with a dome, as in the vault of the crossing of St. George's chapel at Windsor ; or with a pendant as in the vaults of the choir aisles at Bath. Partly intersecting conoids are also adopted in the wonderful pendant vault of Henry VII's chapel at Westminster. The side sections of the high vault have flat spandrels, while the spandrels of the central portion are treated with pendants.

A fan-vault of this kind could easily be planned on a polygonal plan, for the spandrel is much reduced in size. The apse of Henry VII's chapel at Westminster (plate xiv) and the south porch of St. Mary the Virgin, Oxford (plate xxviii), are good examples.

The third great class of fan-vaults consists of those whose conoids completely intersect and which have no central spandrels (fig. 10). This is undoubtedly the most perfect form of all. The earliest examples appear to be those at Sherborne ; every vault in that beautiful church, with the single exception of the vaults of two chapels, is of this type. The elimination of the flat central spandrel renders it specially suitable for large spans, and the vaults of the Peterborough New Work, King's College chapel, the Dorset aisle at Ottery St. Mary, and the Lane aisle at Cullompton are all built in this manner.

In most instances the vault occurs over an oblong plan, but that of the Red Mount chapel at King's Lynn is square (fig. 11). The difficulties of fan-vaulting a polygonal plan are greatly reduced by the employment of intersecting conoids. The most beautiful example is the small apsidal chapel in the cloisters of St. Stephen's, Westminster.

It has already been said that the horizontal section of the conoids of most fan-vaults is circular, while a few have conoids of a polygonal section. This scarcely affects the principles of construction, but it makes a great deal of difference to the setting out and working of the vault stones. The surfaces of a fan-vault with circular conoids are of double curvature and exceedingly difficult to work ; for instance, each panel is concave in the length and convex in the breadth. In the vaults with polygonal conoids the surfaces are of single curvature only, like

the soffit of an arch. It is curious that there are so few examples of polygonal conoids, for they are very beautiful and the effects of light and shade are more satisfactory than the circular conoid, besides being simpler to cut to shape.

It is interesting to compare the fan-vault with the dome. A good definition of a dome is that it is generated by the revolution of a semi-arch about its centre line. Now a fan-vault conoid is generated by the revolution of an arch in the other direction, namely about its perpendicular tangent. Thus a fan-vault conoid is a dome turned inside out. Either could be built in solid blocks of stone, or with panels carved in the solid,¹ or with separate ribs and panels.

There are other resemblances. If it is required to cover a square building with a dome, it is necessary to corbel over the four triangular spaces left in the corners if the radius of the dome is made equal to half the side of the square. The complete fan-vault conoid must be cut into four sections placed in the four corners of the building, and the large central spandrel corresponds to the pendentives or corbelling of the dome. Another method is to make the radius of the dome equal to half the *diagonal* of the square and to cut it down to fit. This variety of dome corresponds to the fan-vault with intersecting conoids; for in this case the conoid has a radius equal to half the diagonal, and is pared down until the bottom is square on plan; then as before it is cut into four quarters placed one in each angle of the building.

THE DECORATIVE USE OF THE CONOID FORM.

The traceried conoid is in itself extremely decorative, and it is interesting to notice the manner in which the corbels of oriel windows,² the bowls of piscinae,³ and the stems of pulpits⁴ are carved into the form of a conoid.

¹ The north porch of Deddington church, Oxon. is ceiled with a stone dome. This has ribs forming tracery patterns like those of a fan-vault. This probably dates from the seventeenth century, though the detail is completely Gothic.

² Nash Manor, Somerset.

³ Wykeham's chapel at Winchester.

⁴ Northleach, Gloucestershire.



BATH ABBEY CHURCH. HIGH VAULT OF QUIRE.





BATH ABBEY CHURCH. S. QUIRE AISLE.

At Maids' Moreton, Bucks. the west door is protected by a quaint stone pentise supported on two corbels of conoid shape (plate xxxv). Yet another decorative use of the conoid is exemplified in the chantry chapel on the north side of the Beauchamp chapel at Warwick, and the Ramrydge chapel at St. Albans, where the surface of their barrel-vaults is studded with little conoidal pendants.

In the chantry chapel of the De la Warrs at Boxgrove, and the Beauchamp chapel at Tewkesbury (plate xxxiv), little traceried conoids depend from a flat stone ceiling slung up to wooden beams, while similar pendants are even used to decorate the conoids of the fan-vault of the passage beneath the garden front of St. John's College, Oxford (plate xxx). Delightful little fan-vaults of microscopic scale occur beneath the canopies of niches ; there are many examples among the niches of Bishop West's chapel at Ely.

IV. DECORATION.

(a) GENERAL PRINCIPLES.

A perfectly developed fan-vault is the most elaborate form of ceiling that has ever been conceived. Its ribs form intricate tracery, its bosses and finials are richly carved and the whole is decorated in colour. It is the custom to contrast the elaboration of the fan-vault with the severe simplicity of the thirteenth-century vaulting to the great disadvantage of the former. As a matter of fact, the severe and simple lines of the thirteenth-century vaulting are mainly due to the whitewashing and scraping of post-reformation days. The thirteenth-century builders did not court simplicity. They saw that the ceiling must be the crowning glory of the church and decorated their vaults with elaborate paintings ; the effect was extremely rich. The later builders preferred to add additional ribs to their vaults, increasing their beauty and strength at the same time. They added more intermediate ribs and liernes, and covered all the intersections with carved bosses. Then they cusped the panels and finally evolved the fan-vault with its tracery ribs.

The principle of making the lower part of a building

plain and solid and gradually increasing the richness and delicacy of the design as the building rises is common to all the greatest works of architecture. One might cite the Greek Doric temples with their plain sturdy fluted columns carrying entablatures of many small members, with finely sculptured metopes; the towers of Somerset with their massive bases, rich belfry stories and ornate clusters of pinnacles; or the Italian campaniles whose windows increase in number in each stage of the design; or the Florentine palaces, heavily rusticated in the lower stage, then very slightly in the second stage, and not rusticated at all in the upper stage, crowned by a cornice with enriched mouldings, dentils and modillions.

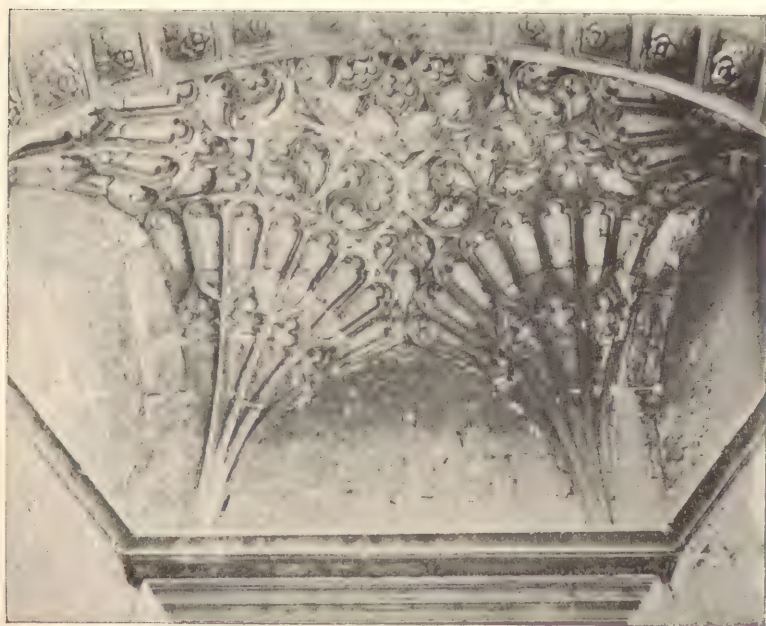
This principle was fully understood by the later builders to whom we owe our glorious lierne- and fan-vaults and our open timber roofs. What can be more satisfactory than a simple Romanesque building with an elaborate fifteenth-century vault, such as we find at Norwich or Oxford? We instinctively feel that such an arrangement is right constructionally and artistically, unless we are biassed by the criticisms of the archaeologists of the last century who have pronounced all such work to be decadent.

And the effect of the fan-vault in a late Gothic church is equally beautiful. Great clusters of shafts, each with its own special purpose, rise from the floor of the church to the springing of the vault, where ribs spring from each shaft and spread in all directions, multiplying and forming delightful tracery in perfect harmony with that of the clerestory windows, which take up all the space between the piers and rise from the pier arches to the vault. Such buildings as the quire of Sherborne or King's College chapel owe their beauty partly to their wondrous unity; but the gradual increase of richness and minuteness of design as the work rises is an even more important factor.

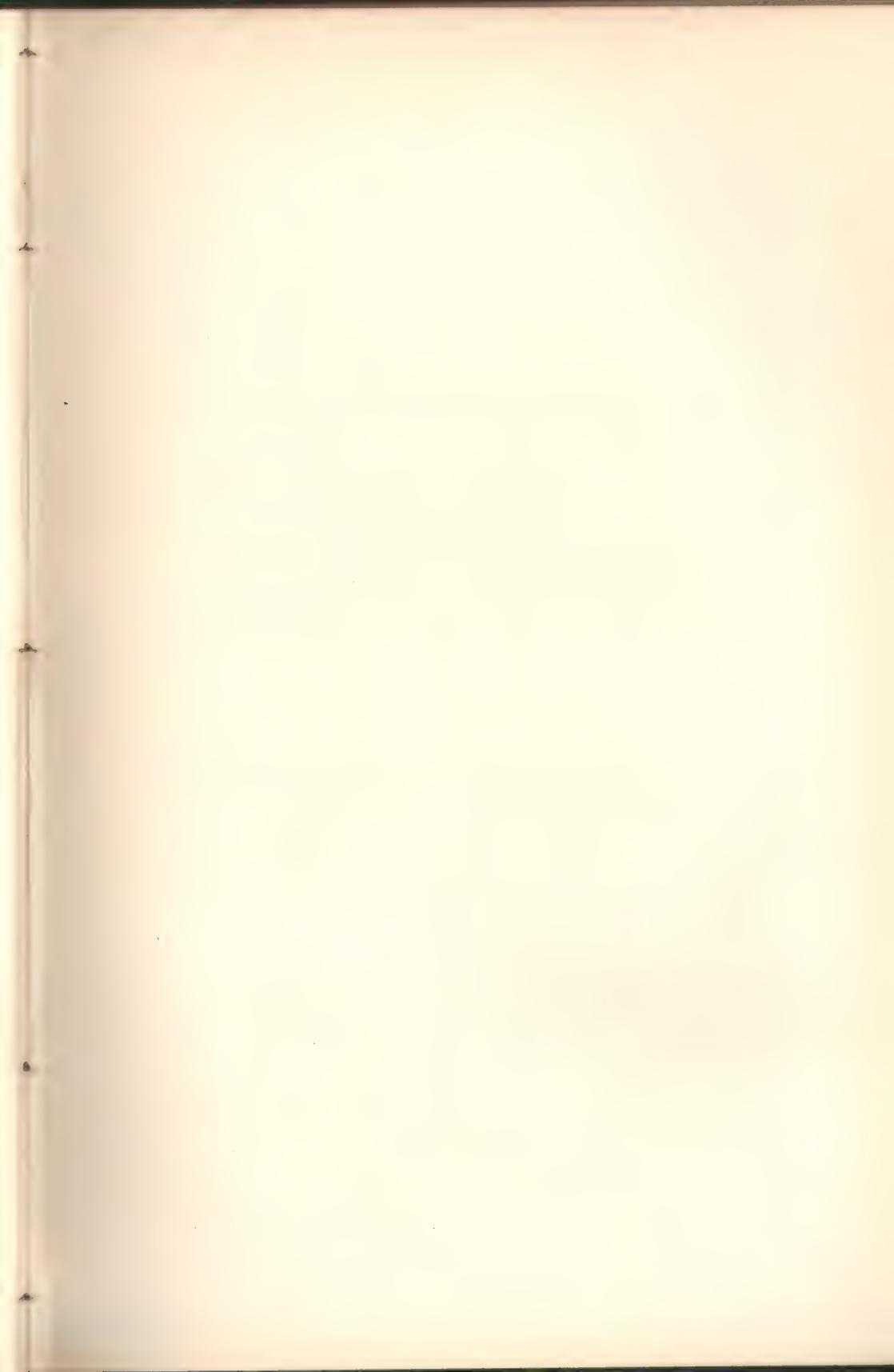
When the fan-vault is used over a little chantry chapel it is just as satisfactory. One can hardly imagine the Audley chapel at Salisbury with a vault of thirteenth-century type. However beautiful the curve of the ribs and the play of light and shade in the twisted panels, it would come as an anti-climax to the elaboration of the wall panelling and reredos. But the fan-vault comes as a crowning beauty.

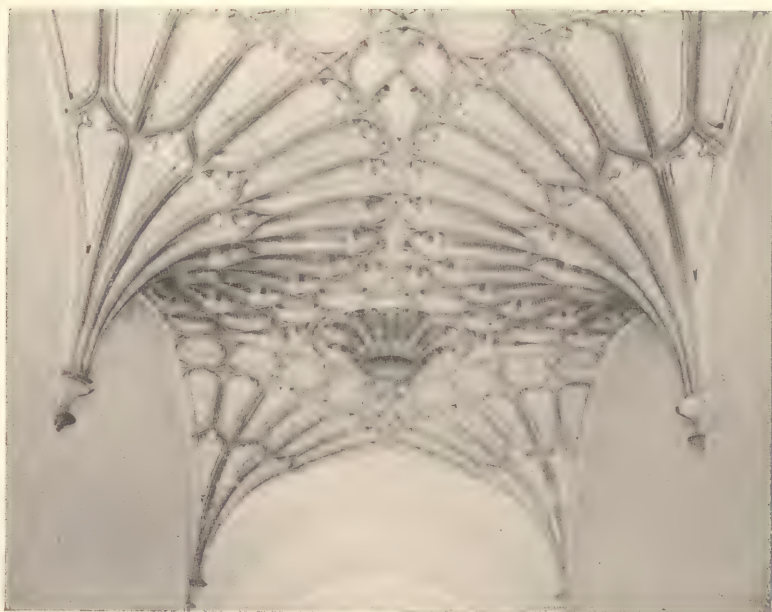


NO. 1. WADHAM COLLEGE, OXFORD. GATEWAY TOWER.

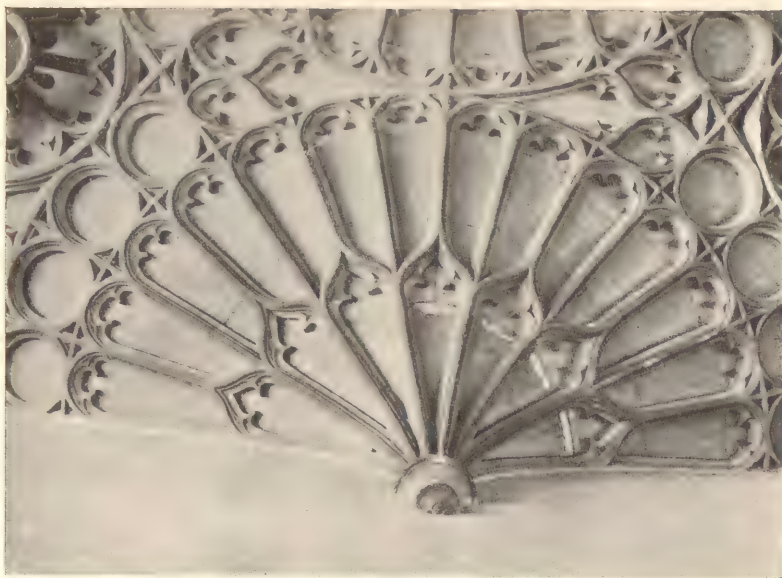


NO. 2. ST. MARY'S CHURCH, OXFORD. S. PORCH.





NO. 1. ST. JOHN'S COLLEGE, OXFORD. PASSAGE TO SECOND QUADRANGLE.



NO. 2. ST. JOHN'S COLLEGE, OXFORD. PASSAGE TO SECOND QUADRANGLE.

(b) TRACERY.

The fan-vault owes a great deal of its beauty to the tracery formed by its ribs. The tracery of the conoids is based upon the radiating lines taken by the ribs, just as the tracery of a fifteenth-century window is based on vertical lines. It is nearly always in two orders:¹ that is to say, the principal ribs are larger than the others. Except in very plain examples² the ribs multiply as they rise, for it is impossible to allow many ribs to spring from the small shafts which are characteristic of the later Gothic work. Thus in the cloisters of Gloucester there are only three ribs to each semi-conoid at the springing, but intermediate ribs are introduced and then lesser intermediate ribs until there are no less than seventeen ribs at the top of the conoid. These form sixteen panels which are grouped in pairs and treated as little two light windows. This often occurs, but generally the arch is four-centred and there is no tracery between the panels and the arch. The rest of the panels are sometimes arched at the top only and sometimes at each end. Both systems can be seen in the east walk of the cloisters at Gloucester.

The number of panels round the top of each quarter conoid is generally either four, eight or sixteen. In those of the Bath quire aisles (plate xxvii) there are six, while in the two small vaults at St. John's College, Oxford (plates xxix and xxx) there are seven and seven and a half respectively. Each panel is usually arched at the top and sometimes at the bottom as well. The arches may be pointed or ogee-headed, trefoiled or cinquefoiled, and they form concentric bands of ornament which have the effect of a transom, especially in the later vaults. The transom is sometimes still further emphasised by the introduction of a band of quatrefoliated circles, each with a carved patera in the middle, as in the rich vault of the Lichfield chapel at Evesham. In those of Henry VII's chapel at Westminster and the passage beneath the garden front of St. John's College, Oxford, each foliated circle is drawn out into an ogee-shaped point at the top so as to fit

¹ Examples of tracery in one order only are the porch of Torbrian church and the St. John's College passages.

² Ottery St. Mary, north porch, Cirencester, north porch, Audley chapel at Salisbury, and others.

into the rest of the tracery, and this has a delightful effect. Double foliation is not often found.¹

The central spandrel, if flat, may be treated in a number of ways. In a few small vaults it is simply divided into four foliated triangles by ridge ribs, as in the vaults of the porch of the Dorset aisle at Ottery St. Mary.² More frequently four quaterfoliated circles are inscribed, while the vaults of Gloucester cloisters (plate II) and the Stanbury chapel at Hereford have eight circles inscribed in their central spandrels, some with four and others with six or eight cusps. Sometimes a single circle is inscribed, foliated as in the Beaufort chapel at Winchester, or containing four foliated circles as in the Lichfield chapel at All Saints', Evesham (plate XVIII).

The tracery of the domes or pendants which are so often used in the central spandrel is usually based on radiating lines like a rose window and is designed on the same principles as that of the conoids.

When the conoids partly intersect, the design of the tracery is a difficult problem. Sometimes it is modified to suit the irregular shape of the ribs bounding the conoid, as at Gloucester (plate III), and in the oriel of the hall of Christ Church, Oxford (plate XX, no. 2). More often there is no modification of the tracery which intersects; this is sometimes unsightly, though generally it is scarcely noticeable (plate XXI). The difficulties of designing the spandrel tracery are reduced, for the diamond is smaller and of more pleasing shape.

The design of the tracery of fan-vaults with completely intersecting conoids is even more troublesome. A transom rib generally starts from the apex of each wall rib;³ below the lower one the conoid is designed in the usual manner, but above this line there is an awkward space to fill in, divided into irregular quadrilaterals and triangles by the radiating ribs of the conoids. Most of the quadrilaterals can be treated like the lower panels, or they may be

¹ The vault of the north transept of Sherborne and the passage beneath the garden front of St. John's College, Oxford, are examples.

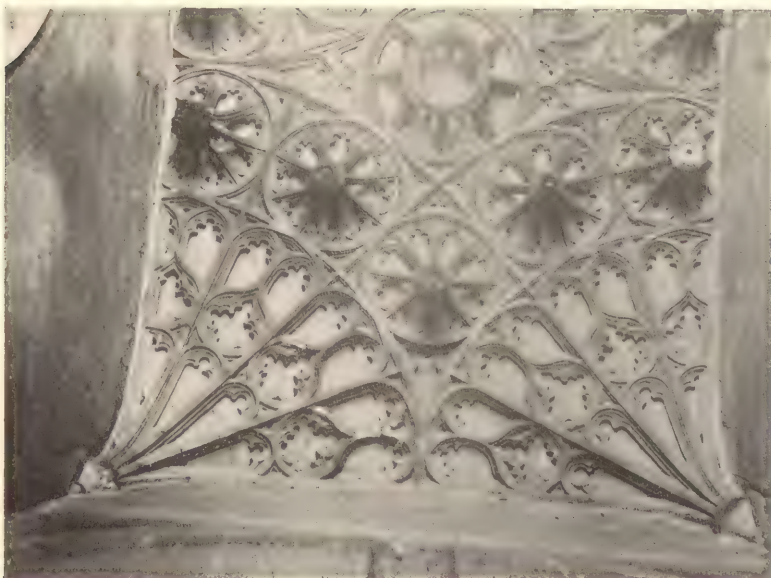
² Also in the vaults of the chamber on the north side of the chapel of Magdalen College, Oxford, and the chantry chapel

known as the "watching chamber" in Oxford cathedral church.

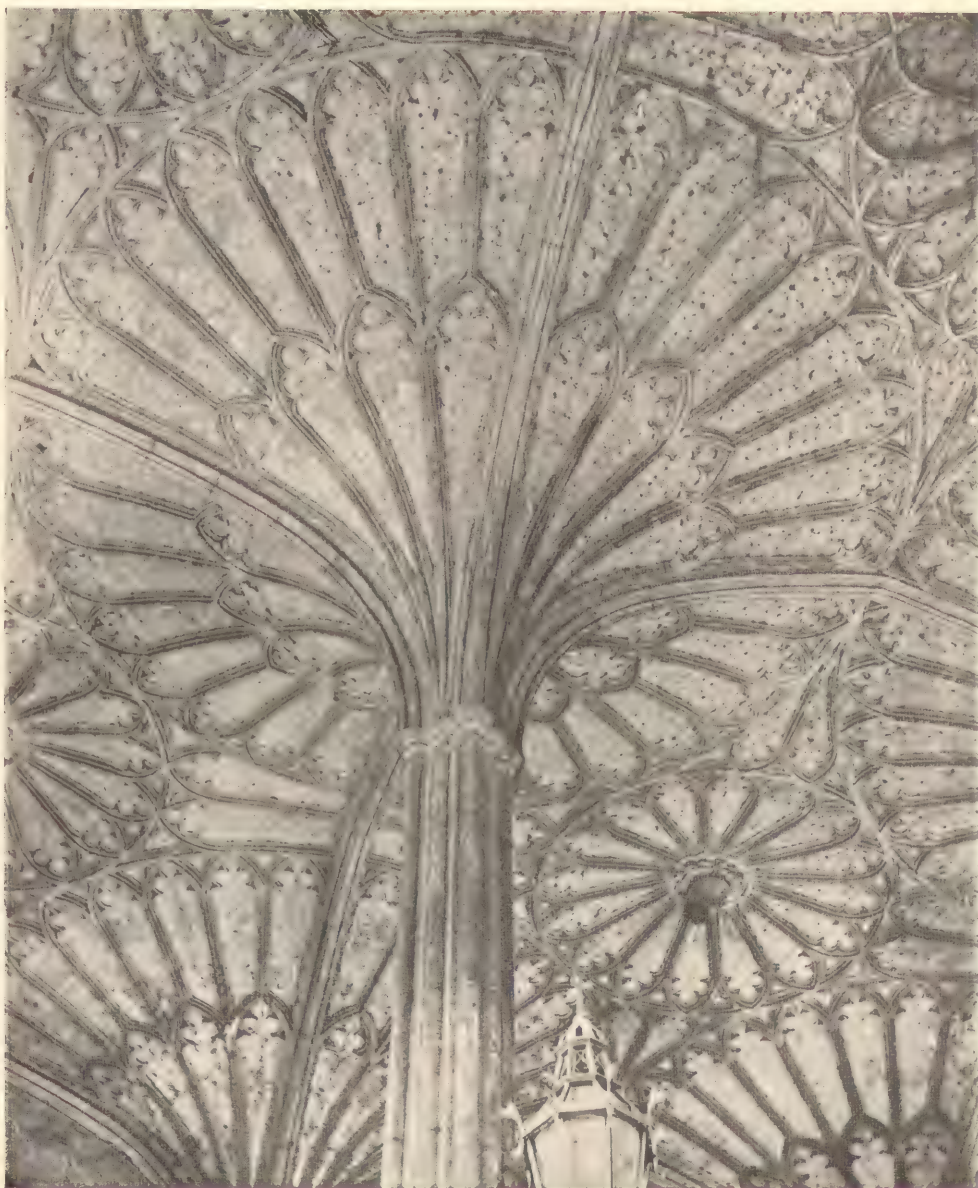
³ In Sherborne nave the lower transom rib starts from the intersection of the two intermediate ribs nearest to the wall. The upper transom is replaced by a straight rib, in continuation of the line of the other intermediate rib.



NO. 1. ORIEL COLLEGE, OXFORD. GATEWAY TOWER.



NO. 2. ST. JOHN'S COLLEGE, OXFORD. PASSAGE BENEATH GARDEN FRONT.



CHRIST CHURCH, OXFORD. HALL STAIRCASE.

divided into two triangles; others may be treated as much like the panels as their shape will permit. The triangles may be foliated or left plain if they are very small. A certain amount of irregularity is inevitable, but it all adds to the beauty of the design. The treatment of the vaults of Sherborne, Ottery St. Mary and Cullompton is especially clever; the King's College vaults are not so well designed.

There are a few instances of very elaborate tracery upon the surface of the fan, as in the porch of St. Mary's, Oxford, where ellipses filled with flamboyant tracery are employed. These correspond to the pendants which are found in the vault of the garden front passage at St. John's College, Oxford.

These brief notes are merely intended to show the main principles of the design of fan-vault tracery. An enormous number of arrangements of the main ribs is possible, and each arrangement may have many different effects, according to the design of the lesser ribs and cusping and the curve of the vault itself.

(c) CARVING.

Little carving is found in the earliest fan-vaults. In the two early chantry chapels at Tewkesbury (plate 1, no. 2) the only carving is the minute cusp finials which are simple lobed leaves. The cusps of the vaulting of the cloisters at Gloucester terminate in small rosettes. In the latter work the cusp finials are sometimes more elaborate, as in the lower vault of the Beauchamp chapel at Tewkesbury, where they are well carved Tudor leaves (plate xxxiv), and in the vault of the Lichfield chapel at St. Lawrence, Evesham, where the cusps terminate in minute but delicately carved balls of foliage or in little portcullises.

The quatrefoiled circles of the tracery frequently enclose a well carved square flower or patera. Beautiful work of this kind occurs in the chapel of St. Catherine at Cirencester, and the Lichfield chapel in All Saints church at Evesham (plate xviii). Those of the Audley chapel at Hereford are in some cases nearly hidden by shields bearing coats of arms, while in one bay of the vault of the

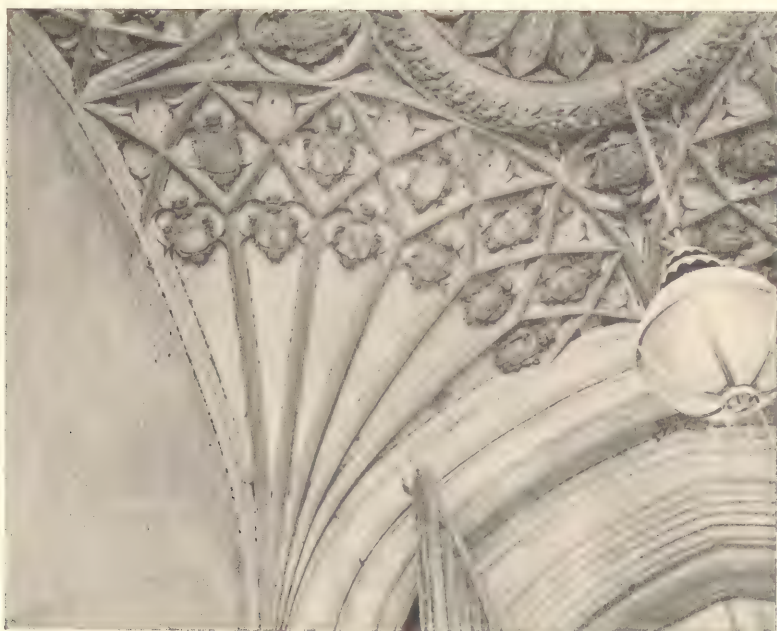
south porch at Cirencester charming little figures of angels are substituted for carved foliage.

Bosses at the intersections of the ribs are not often used. Those of the fine series of polygonal fan-vaults at Sherborne are excellent work. Other examples occur in the Waynflete chapel in Magdalen College, Oxford, and in the lower stage of the two-storied chantry chapel at Christ Church. In the vaults of King's College chapel, Cambridge, there are huge bosses in the centre of each bay in the form of Tudor roses (plate xii). Similar bosses are found in the lady chapel of Peterborough, and, on a small scale, in the north porch of Hillesden church, Bucks. (plate xxxiv). The vault of the porch to the Dorset aisle at Ottery St. Mary has a central boss with stalky foliage growing from the mouth of a grotesque horned head.

The vaults with pendant conoids in the central spandrel often show beautiful work in the hanging capitals in which the pendants terminate. These are usually treated with a cresting of Tudor flower ornament, a trail of foliage round the bell and a boss, rose or shield to finish off the lower part. Examples of this treatment are to be found in the chapel of St. Lawrence church, Evesham, in the oriel of Christ Church hall, Oxford (plate xx), and in the vaults of Henry VII's chapel at Westminster. The pendants of the quire aisles of Bath abbey are finished off with a cluster of crockets.

In many late fan-vaults the central boss is enlarged, until it nearly fills the middle spandrel of the vault, and is decorated chiefly with heraldry or emblems. The vaults of the vestibules to the aisle chapels of Henry VII's chapel, the chantry chapel of bishop Audley at Salisbury (plate xvii), the chantry chapel of the countess of Salisbury, Christchurch, Hants. and the cloisters of St. Stephen's, Westminster, are decorated with heraldic bosses of this kind. A similar boss masks the intersection of the conoids of the vault of the Christ Church hall oriel.

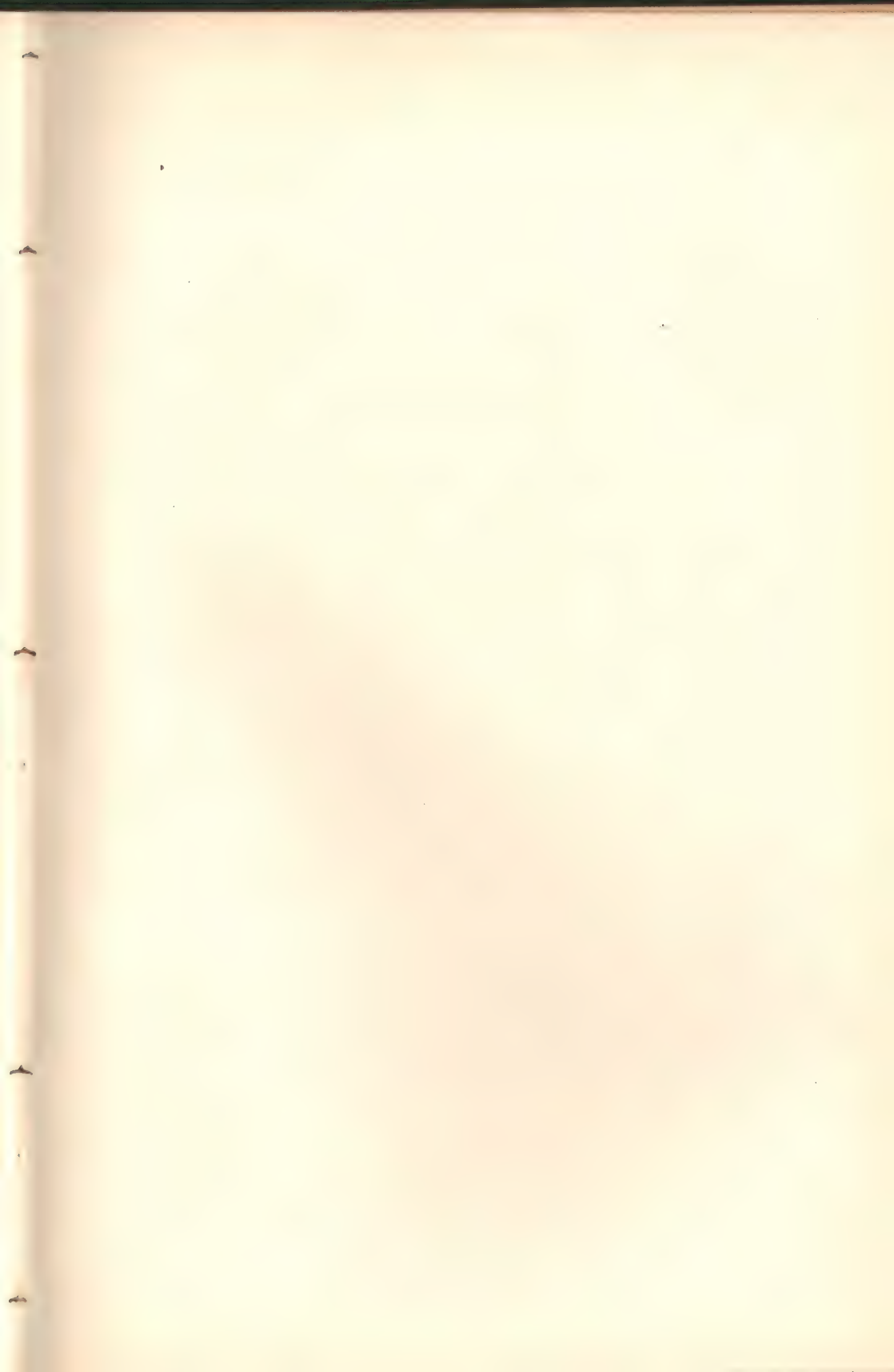
Occasionally the transom ribs of the conoids are emphasised by an edging of Tudor flower ornament. This may have been suggested by the finialed cusps of the vault of the Red Mount chapel at King's Lynn (fig. 11). More fully developed examples are the vaults of King's College chapel, Cambridge, and the eastern chapels of



NO. 1. CHRIST CHURCH, OXFORD. TOM TOWER.



NO. 2. UNIVERSITY COLLEGE, OXFORD. GATEWAY TO RADCLIFFE QUADRANGLE.





GLoucester Abbey Church. CONOID AT ANGLE OF CLOISTERS.

Peterborough, but here the ribs cut through the bands of Tudor flower. In the porch of Lavenham, Suffolk, and the high vault of Henry VII's chapel, the rings of Tudor flower project in front of the ribs and are continuous. A Jacobean version of this style of decoration may be seen in the vault of the gateway of Wadham College, Oxford.

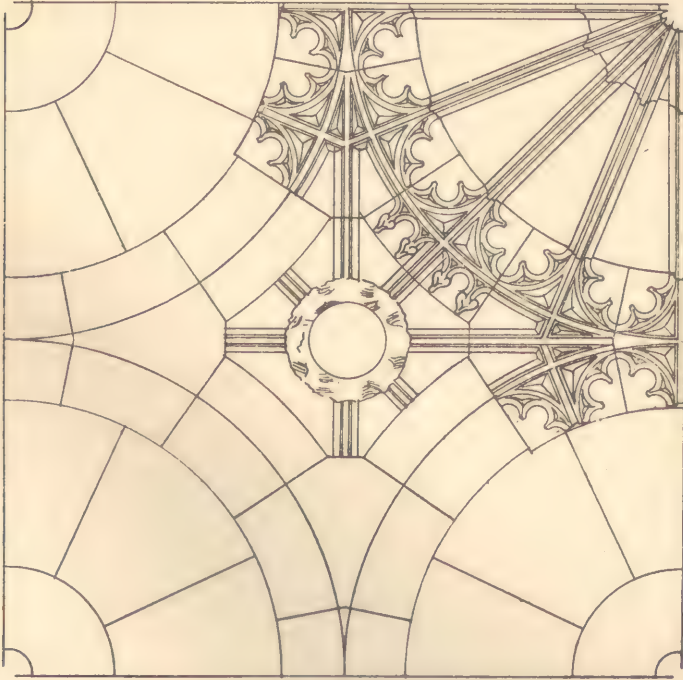


FIG. II.
VAULT OF CHANTRY OF THE RED MOUNT, KING'S LYNN.

Figure sculpture is rare. Small figures of angels very rudely carved are introduced in the Torbrian vault, interrupting the diagonal ribs (fig. 9). The central bosses of the vaults of the chapels of Waynflete and Beaufort at Winchester are decorated with very beautiful little carved and coloured angels. In the Salisbury chapel at Christchurch, Hants. there is a large boss, now much mutilated, but once carved with a beautiful representation of the Coronation of Our Lady, with the Holy Trinity, surrounded with winged cherub heads in the Italian style,

and at Hereford, in the Audley chapel the central boss contains an Assumption of simple design (plate xxxv).

After the renaissance, carving is applied to the vault in all manner of forms. The vault of the porch of Cowdray house, Sussex, has emblems carved in shallow relief in the panels of the vaulting, while the ribs are decorated with Italian ornamentation. The spandrels of the tracery are in some cases filled with winged cherub heads, and a beautifully modelled Tudor flower ornament edges the fans. The late work in the Oxford colleges is sometimes loaded with strap-work and heraldry. The vault of Tom tower has no fewer than forty-eight shields, surrounded with arabesques (plate xxxii, no. 1); great bosses of strap-work, breaking out into acanthus foliage framing coats of arms, are an interesting feature of the two eighteenth-century vaults of University College (plate xxxii, no. 2).

(d) COLOUR DECORATION.

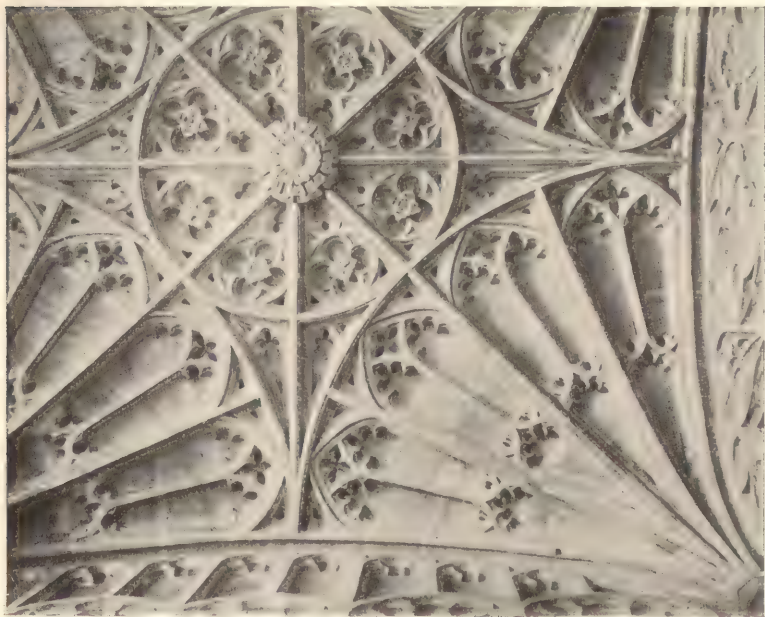
It is impossible to say whether the practice of decorating the vaults in colour was a usual one or not for the remaining examples of painted fan-vaults are so few in number. Not many retain their colour unrestored, and some have been scraped comparatively recently. The vaults of the Despencer and Fitz-Hamon chapels at Tewkesbury are said to have been coloured, but not a trace remains.

The canopy of the Despencer monument at Tewkesbury, which is in the form of a fan-vault (plate i, no. 1), has been painted red, inclining to terra-cotta, and the ribs which were painted upon the surface of the vault were probably a greenish stone colour, with black lines to imitate mouldings. A similar scheme occurs in the vault of the lower story of the Audley chapel at Hereford, which is not a fan-vault, but a ribbed-vault with painted "fan-tracery" in its panels.

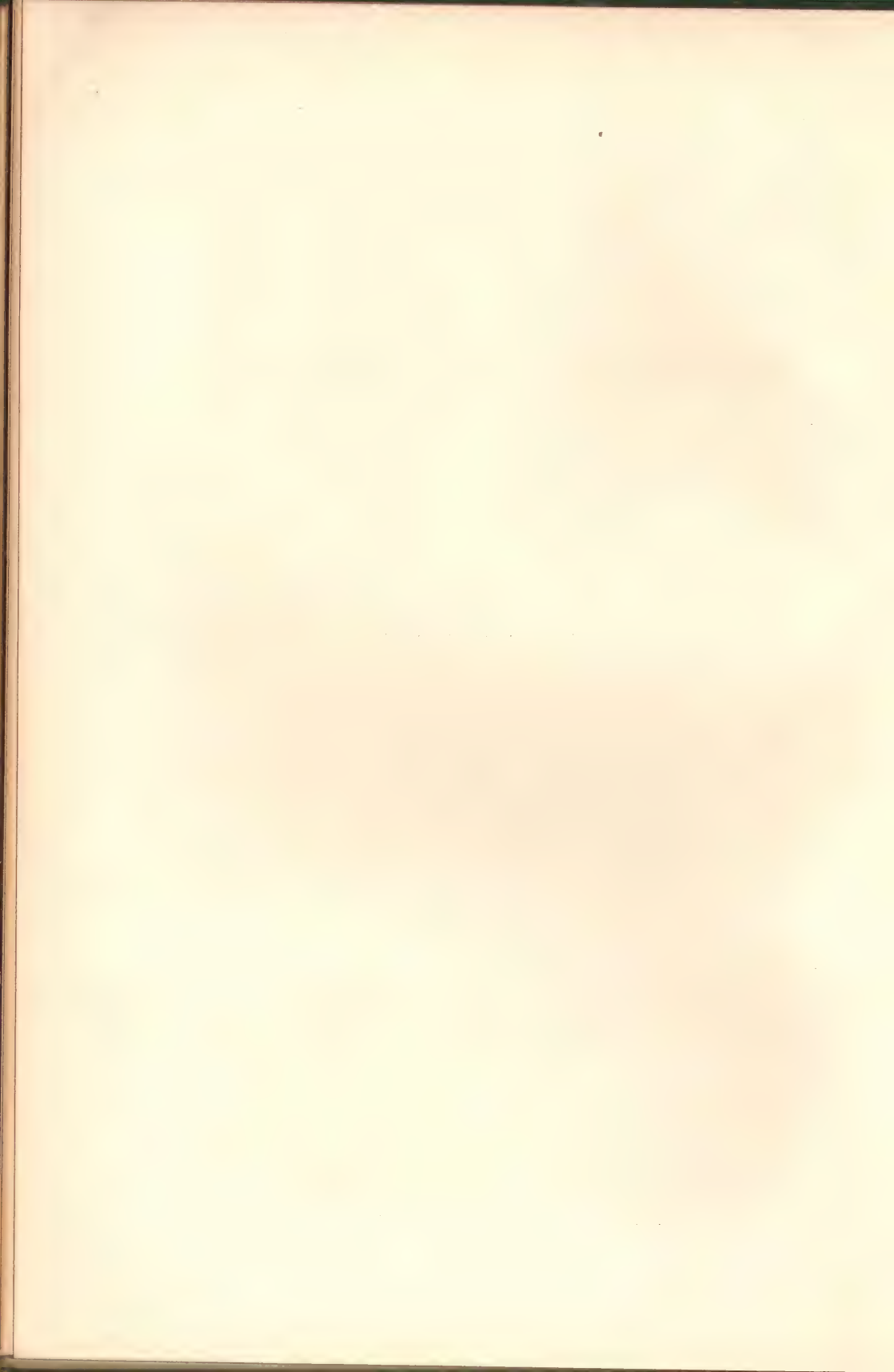
The lower vault of the Beauchamp chapel at Tewkesbury (plate xxxiv) has a more elaborate scheme of colour decoration. The panels are deep blue, and the carving is gilded. The ribs have their ogee mouldings painted red and the hollows green, while the fillets are gilded. The colour scheme of the upper story of the Audley chapel at



NO. 1. TEWKESBURY ABBEY CHURCH. BEAUCHAMP CHAPEL. LOWER VAULT.



NO. 2. HILLESDEN CHURCH, BUCKS. N. PORCH.



Hereford is the same, but the colours are not so deep and subdued and appear to have been restored. That of the south-west chapel of St. George's chapel at Windsor is similar, but the ribs have white hollows with red eyes.

In all these cases the stone is entirely hidden by the colour, but it was not unusual to confine the colour decoration to a few parts of the vault, leaving a large portion plain. The painting of the north-west chapel may be coeval with the monument of princess Caroline. The panels of the fans are left plain; while those of the central star are blue, and the surrounding quatrefoils red, with carved devices picked out in red and green. The ribs are left plain save for the gilded fillets. The vault of the Audley chapel at Salisbury has deep blue panels, shaded to green, and the ribs are left plain, except for the fillets, which are gold. The two heraldic bosses are also painted. The western has an elaborate gold knot on a dark brown-red field. The eastern has the same coat impaling Salisbury, a figure of Our Lady on a blue field. The wreaths of roses and pomegranates are also coloured and gilded.

In the Lupton chapel, built between the buttresses of Eton College chapel, there is a beautiful coloured fan-vault. Here again the stone is not completely hidden by the paint. The panels are a deep blue and the fillets of the ribs are gilded, while the shield which completes the pendant is emblazoned in heraldic colours. The general scheme is the same as that of the Audley chapel, but the tones of the colours are very different.

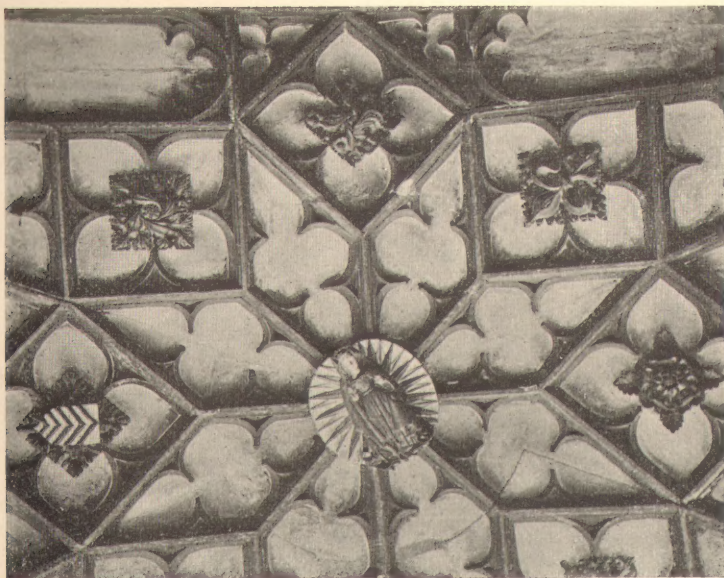
The vaults of the Beaufort and Waynflete chapels at Winchester are uncoloured, save for the angels bearing shields in the midst of the vault: these are very charmingly painted.

Even high vaults were occasionally painted. The colour decoration of the vault of the quire of Sherborne is modern and of Victorian character. Before restoration the panels were of chalk and the ribs of yellow Ham Hill stone, and the whole was covered with a wash of yellow ochre which may have been original. The vaults of the nave and transepts have their bosses picked out in colour and gilding, but this is also modern.

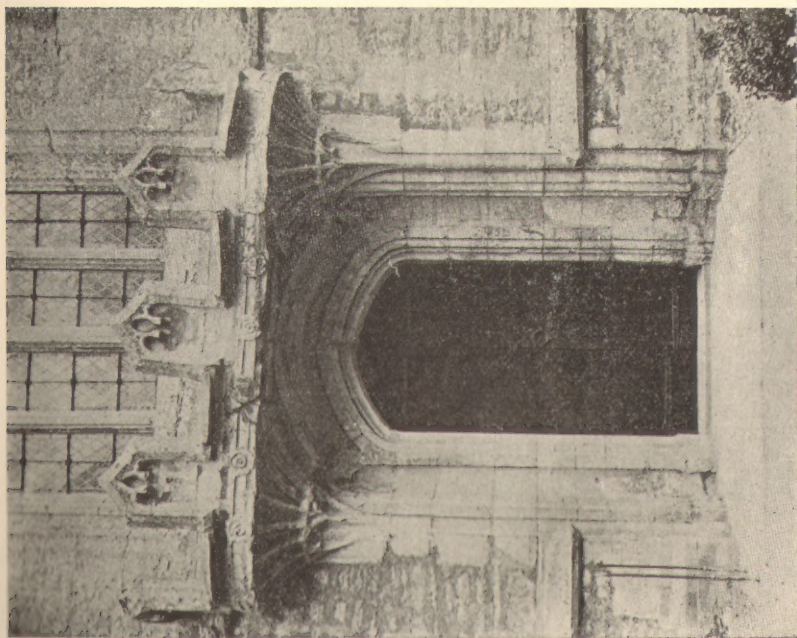
At Bath the colour decoration is confined to the central spandrels. In the quire vault the tracery is coloured red

with white fillets and gold cusp finials and the panels are blue. The shields are picked out in heraldic colours. In the north transept the only colour besides that of the shields is the blue of the main panels. The tracery is left white stone. In the vault of the crossing of St. George's chapel at Windsor the panels of the central rose are painted deep blue. This is the only colour upon the vault beside the heraldic decoration.

It is known that the great vault of King's College chapel was to have been painted. There is an estimate for the work attached to the petition addressed to the king by the provost and scholars in 1515. It may be gathered from this that each of the twelve bays was to be painted and gilt at a cost of £26 13s. 4d, making £320 in all; thus the cost of the work amounted to between three and four thousand pounds of our money.



NO. 2. HEREFORD CATHEDRAL CHURCH, AUDLEY CHAPEL.



NO. 1. MAIDS MORETON CHURCH, BUCKS. W. DOOR.

